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The
Geographical Journal.

No. 4. APRIL, 1900. Vol. XV.

A BATHYMETRICAL SURVEY OF THE FRESH-WATER LOCHS OF SCOTLAND.*

By Sir JOHN MURRAY, K.C.B., D.Sc., F.R.S., and FRED. P. PULLAR, Esq., F.R.G.S.

Part I.—The Lochs of the Trossachs and Callander District.

Introduction.

About forty years ago excellent bathymetrical charts of Loch Lomond and Loch Awe were published by the Hydrographic Department of the Admiralty, based on surveys undertaken by naval officers. Some of the general charts of the Scottish coasts published by the Admiralty also show a few soundings down the centres of the fresh-water lochs forming the Caledonian Canal, viz. Loch Ness, Loch Lochy, and Loch Oich, but the charts of Lochs Lomond and Awe represent the only systematic surveys of the fresh-water lochs in Scotland that existed previous to the year 1883.

About that time many scientific men in Scotland felt that a survey of these fresh-water lochs should be undertaken, which led to the Councils of the Royal Societies of London and Edinburgh bringing this subject under the notice of Her Majesty's Government, as shown in the following correspondence:—

I. *The Secretary of the Royal Society of Edinburgh to the Secretary of H.M. Treasury.*

Royal Society of Edinburgh, July 11, 1883.

Sir,—In consequence of the investigations now being carried on with reference to the physical and biological conditions of the Scottish fresh-water lakes, and also because of the importance, in certain branches of geological inquiry, of knowing

* Maps, p. 452.

the form of the basins occupied by these lakes, it has been prominently brought under the notice of the President and Council of this Society, that no bathymetrical survey of these lakes exists.

I have, therefore, been requested by the President and Council to ascertain from H.M. Government if there is any probability of this work being soon undertaken, and, at the same time, to state that it would be a great satisfaction to the President and Council to learn that instructions had been issued by the Lords Commissioners of H.M. Treasury to the Officers of the Ordnance Survey, or of the Hydrographic Department of the Admiralty, to undertake a survey of a few of these lakes similar to the excellent ones already made of Loch Lomond and Loch Awe—say Lochs Morar, Maree, Lochy, Assynt, Shin, Tay, Ericht, Rannoch, Earn, Doon (in Ayrshire).—I am, etc.,

(signed) P. G. Tait,
Secretary, Royal Society, Edinburgh.

II. *The Secretary of H.M. Treasury to the Secretary of the Royal Society of Edinburgh.*

Treasury Chambers, September 17, 1883.

Sir,—With reference to your letter of the 11th of July last, and the reply from this Board, dated the 10th ultimo, relating to a proposal to execute a bathymetrical survey of certain fresh-water lakes in Scotland, I am directed by the Lords Commissioners of Her Majesty's Treasury to acquaint you that my Lords are informed that the nautical surveys of Loch Lomond and Loch Awe, referred to in your letter, were undertaken by naval officers in the interests of navigation, and that the same considerations do not apply to the other lochs, of which surveys are suggested in your letter.

My Lords are also informed that the proposed bathymetrical surveys do not come within the functions of the Survey Department of the Office of Works (late Ordnance Survey).

Under these circumstances, my Lords regret that they are unable to sanction the proposed surveys. I have the honour to be, etc.,

(signed) Leonard Courtney.

III. *Discussion in the House of Lords.*

In March, 1884, in reply to Lord Balfour of Burleigh in the House of Lords, Lord Sudeley said—

In reply to the noble Lord, I have to state that the operations of the Ordnance Survey have been hitherto restricted to such portions of the ground in the vicinity of fresh-water pools, and inland sheets of water generally, as are above the lowest water-levels. It is quite true, as the noble Lord has stated, that Loch Lomond and Loch Awe were surveyed, but that was undertaken by naval officers in the interests of navigation. The Government consider that a bathymetrical survey of all the lochs of Scotland would clearly be outside the function of the present Ordnance Survey of Scotland, which is already completed. Even if it were desirable, as the noble Viscount [Bury] has suggested, men would be taken off their work in England and the southern counties to carry this work out, and the general survey would be very much delayed. Such investigation would, no doubt, be most interesting from a scientific point of view in certain branches of geological inquiry to ascertain the forms of the basins occupied by the lakes. The Government will give the suggestions made by the noble Lord full consideration, and there will be no objection to lay the papers on the table.

IV. *The Secretary of the Royal Society of London to the Secretary of H.M. Treasury.*

The Royal Society, Burlington House, May 2, 1884.

Sir,—The President and Council of the Royal Society have had under consideration a communication from the Royal Society of Edinburgh, from which it would appear that the Lords Commissioners of Her Majesty's Treasury have stated that they are unable to sanction a bathymetrical survey of certain of the Scottish lochs, as proposed by the Royal Society of Edinburgh.

I am directed by the President and Council of the Royal Society to assure my Lords that they fully share the regret expressed by the Royal Society of Edinburgh that my Lords should have arrived at such a decision.

Neither from a topographical nor from a geological point of view can the survey of the United Kingdom be considered complete so long as the depths of the several inland waters remain unknown, and the absence of adequate data, concerning not only the Scottish lochs, but other large inland waters of the United Kingdom, forms, and will continue to form, a very serious obstacle to geological research.

The President and Council do not desire to urge upon my Lords any elaborate surveys entailing a large expenditure. They have reason to believe that the most important objects of the proposed surveys would be gained if series of soundings were carried across the important lakes not yet bathymetrically surveyed, at moderate intervals in each case. The exact closeness of the lines of soundings and the interval between each two soundings in each line must, in great measure, be determined at the time of observation according to the results which are from time to time obtained; but it has been suggested that lines of soundings at about a quarter of a mile interval, with soundings about 100 yards apart, would probably be found generally useful.

The President and Council venture to remind my Lords that the carrying out of such a bathymetrical survey is much facilitated by the fact that the contours of the lakes in question have all been already accurately laid down; also that the inland waters of the continent have been carefully surveyed by the several European Governments; and that, though in Scotland only Lochs Lomond and Awe have been surveyed (notwithstanding that some of the others are used for purposes of navigation) and the English lakes not at all, several of the Irish lakes were sounded by the Admiralty surveying officers in the years 1834–39 and in 1846.

The President and Council fully appreciate the difficulty which presents itself to my Lords in the facts that such bathymetrical surveys as those proposed do not fall within the province of the Survey Department of the Office of Works, and that, since the object sought is not one concerning navigation, they are foreign also to the duties of the Admiralty. The object, indeed, of the proposed survey may be most fitly spoken of as geological, but the Geological Survey has no means of carrying out such a work.

The President and Council would, however, venture to urge upon my Lords that the proposed survey, though of great scientific importance, is limited in scope and special in character, and so far not of a nature likely to establish an undesirable precedent, and they sincerely trust that my Lords may be led to reconsider their decision, and may see their way to make some arrangements by which a bathymetrical survey of the various inland waters of the United Kingdom not yet so surveyed may be speedily carried out.—I have, etc., (signed) M. Foster,

Sec. R.S.

There was no practical outcome from this correspondence; the Government declined to undertake any of the proposed surveys.

In the year 1888, Mr. J. S. Grant-Wilson published in the *Scottish Geographical Magazine* * an account of Lochs Tay, Earn, Rannoch, and Tummel in Perthshire, with special reference to the glaciation of the district, and he gives small contoured maps of these lochs, in which the positions of some of the deeper soundings are laid down. This, together with the Admiralty charts of Lochs Lomond and Awe, appears to be all the published information with respect to the depth of the Scottish fresh-water lakes. Attempts have, however, frequently been made, by neighbouring proprietors and others, to ascertain the depth of many of these lochs. About twelve years ago Mr. J. Y. Buchanan recorded the great depth of 175 fathoms in Loch Morar, and this was subsequently confirmed through numerous soundings taken by Sir John Murray, who recorded a depth of 180 fathoms near the same place. Sir John Murray and Mr. J. Y. Buchanan likewise took many soundings in the lochs of the Caledonian canal. Some of the English lakes have been surveyed within recent years by Dr. H. R. Mill, who gives an excellent account of his work in the *Geographical Journal* for 1895.†

* Vol. iv. p. 251.

† The subject of Limnology has lately excited a great deal of interest, especially on the Continent and in America. The following are some of the more important publications:—

Forel, F. A., 'Le Léman, mongraphie limnologique.' 2 vols. Lausanne, 1892 and 1895; and papers published in the *Arch. des Sci. phys. et nat.* Genève, 1886–1895.

Forbes, S. A., "On some Lake Superior Entomostraca," *U.S. Fish Comm. Report* for 1887; also Reports of the Director of the Illinois State Laboratory of Natural History since 1894.

Belloc, E., several Papers published between 1890 and 1894, in the Reports of *Assn. franç. pour l'Avanc. des Sciences*, in the *Comptes Rendus*, in the *Annuaire du Club Alpin français*, etc.

Zacharias, O., 'Forschungsberichte aus der biologischen Station zu Plön,' Theil i.–iv. Berlin, 1893–96.

Evermann, B. W., Papers on rivers and lakes with reference to fish environment in the *Bull. U.S. Fish Comm.*, vols. xiii., xvi., and xvii., 1893–97.

Reighard, J. E., "A Biological Examination of Lake St. Clair," *Bull. Mich. Fish Comm.*, No. 4, 1894.

Thoulet, J., "Contribution a l'étude des Lacs des Vosges," *Bull. Soc. Geogr. Paris*, sér. 7, t. xv. p. 557, 1894.

Marinelli, O., "Area, profondità ed altri elementi dei principali laghi Italiani," *Rivista geogr.*, 1894–95.

Magnin, A., 'Les Lacs du Jura.' Paris, 1895.

Penck, A., and Richter, E., 'Atlas der österreichischen Alpenseen,' Lief. i. and ii. Folio. Wien, 1895–96.

Mill, H. R., "Bathymetrical Survey of the English Lakes," *Geographical Journal*, vol. vi. pp. 46 and 135, 1895.

Ward, H. B., "A Biological Examination of Lake Michigan in the Traverse Bay Region," *Bull. Mich. Fish Comm.* No. 6, 1896.

Kofoid, C. A., "Plankton Studies," *Bull. Illinois State Lab. Nat. Hist.*, vol. v. p. 1, 1897.

Marsh, C. D., "On the Limnetic Crustacea of Green Lake," *Trans. Wisconsin Acad. Sci.*, vol. xi. p. 179, 1897.

Delebecque, A., 'Les Lacs français,' text 4to, with folio atlas. Paris, 1898.

In the present paper we propose to give the results of our numerous recent observations as to the depths in Lochs Katrine, Arklet, Achray, Vennachar, Drunkie, Lubnaig, Voil, and Doine, all of which belong to the catchment-basin of the river Teith, and have a special interest from being directly or indirectly connected with the excellent water-supply to the city of Glasgow.* It is true that at the present moment Loch Arklet belongs to the catchment-basin of Loch Lomond, but the Corporation of Glasgow has power to divert its waters into the catchment-basin of Loch Katrine.

Methods.

To undertake a survey of these fresh-water lochs with the ordinary hand-line would have occupied a very long time; in order to accelerate the work, it was essential to procure a portable wire sounding-machine that could be used in small rowing-boats. Such an instrument was exhibited by Dr. Ule at the Sixth International Geographical Congress in London in 1895. This apparatus was purchased, and with it numerous soundings were taken in Loch Morar, in Lochs Frisa, Ba, and Uisg in Mull, and also in Lochs Katrine, Lubnaig, and other lochs. After a few months' use, however, the machine—which was more or less of a toy—

* In the year 1855 the Corporation of Glasgow was empowered by Act of Parliament to raise Loch Katrine 4 feet above, and to draw it down 3 feet below the previous summer level, thus giving a total available depth of 7 feet for the supply of water to the city, the quantity of water to be drawn from the loch being restricted to fifty million gallons in twenty-four hours. For the purpose of providing compensation water to the riparian owners on the river Teith, power was also given to raise Loch Vennachar 5 feet 9 inches above its previous summer level, and to draw it down 6 feet, and also to raise Loch Drunkie 25 feet. An aqueduct was built from the southern shore of Loch Katrine to Glasgow, 8 feet wide and 8 feet high throughout, with a semicircular top, and having a fall towards Glasgow of 10 inches per mile. At first only a portion of the available fifty million gallons per day was conveyed to Glasgow, but by the end of 1881 the whole of the works necessary to complete the original design were finished. In the year 1884 it was found necessary to provide a larger quantity of water in order to keep pace with the growth of the city, and it was then found that the roughness of the rock sides of the aqueduct had a very retarding influence upon the velocity of the water, and that the aqueduct could not be made to discharge more than forty-two million gallons per day. Power was subsequently obtained from Parliament to build a second aqueduct, to raise Loch Katrine an additional 5 feet, and to convert Loch Arklet, which flows into Loch Lomond, into a reservoir by raising it 25 feet in level. These works are now in progress, and when completed are estimated to give a supply of seventy-five millions of gallons of water per day to the city of Glasgow. Should a still greater supply be necessary in the future, it is believed this can be obtained by connecting Loch Doine with Loch Katrine by a tunnel through the intervening hills, and by constructing an embankment at the bottom of Loch Doine to raise the water-level 30 feet, and another at the bottom of Loch Voil to raise the water-level of that loch 10 feet, and if still more water were wanted Loch Lubnaig could furnish it (see papers by James M. Gale, Esq., M. Inst. C.E., in the *Trans. Inst. Engineers in Scotland*, vols. vii., xii., xxvi., and xxxviii., and his Report on the proposed extension of the Glasgow Corporation Water Works, dated May 17, 1884).

turned out untrustworthy, and was consequently discarded. Subsequently Mr. Pullar designed the sounding-apparatus shown in Fig. 1, which in his hands has worked admirably and accurately.

FIG. 1.—F. P. PULLAR'S SOUNDING-MACHINE.

Description of the Pullar Sounding-Machine.

The sounding-machine (see Fig. 1) is constructed of steel cycle tubes, which are held in position by means of gun-metal brackets, and is divided into two sections in order to pack into as little space as possible for transport. The first section consists of a bracket, carrying two upright tubes, with an adjustable clamp (K), by means of which the machine is fixed to the gunwale of the boat. Over the ends of the two upright tubes, at the disconnecting joint (L), is slipped the second section of the machine, consisting of two horizontal tubes, to which the drum with the sounding wire, measuring pulley, indicating dials, grease-box, etc., are all fixed. The drum (A), which carries the wire, is a small suspension wheel, with a U-shaped rim, tangent spokes, and gun-metal hub. The hub has cone bearings, which can be screwed up, so that any wear may be allowed for. The rim of the drum is capable of holding over 1000 feet of three-strand galvanized steel wire (F). On the hub of the drum is fixed a bronze pinion wheel, in gear with another pinion wheel fitted with a crank handle (B), by means of which the wire on the rim of the drum may be wound in, and on the other side of the hub is an adjustable band-brake (E) intended to regulate the speed of the wire when running out. There is also a stop for the purpose of preventing the weight from running out when the machine is not in use. The wire, after leaving the drum, takes a complete turn round a measuring pulley (G), then through a grease-box (M), and over a guide pulley (H), to the weight (I), which takes the form of a sounding-tube constructed to procure a sample of the deposit, with flap-valve (J) at the foot, the wire being attached to the weight by means of a splice and clip-hook. The measuring pulley has a circumference of nearly 1·foot (measured through the centre of the wire it is exactly 1 foot), so that for every foot of wire which runs out the measuring pulley makes one revolution. The motion of the measuring pulley is transmitted to a series of indicating dials (1, 2, and 3), one recording feet, another tens, and a third hundreds of feet. When the weight strikes the bottom the motion ceases, and the depth may be read off the indicating dials. The dials fitted to the present machine read only to a depth of 999 feet 6 inches, but by the addition of an extra dial greater depths could be sounded.

All the soundings recorded in this paper were taken from small rowing-boats, with the exception of a few obtained from Mr. Dunsmure's steam yacht on Loch Katrine, and they were all taken with Mr. Pullar's sounding-machine. It was usual to pass from side to side of a loch along definite lines, the length of the lines and the distances between them being ascertained from the 6-inch Ordnance Survey maps, which were throughout used for plotting the positions of the soundings. Before making a section across a loch, the boatman was trained for some time to ascertain the distance covered in ten, fifteen, twenty, and fifty strokes. The position on the line of soundings was determined by reference to poles or other objects placed one behind the other on shore, and by the

FIG. 2.—METHOD OF SOUNDING.
(From a photograph by Lady Murray.)

number of strokes between each position. When necessary the position was determined by means of a pocket sextant, and frequently the position of the soundings near the shore was ascertained by measurement with tape lines, or cords several hundred feet in length, stretched from the shore. In addition to the cross-lines, soundings were usually taken in several positions between the lines. When any special feature was indicated by the soundings, a series was taken in a radial manner from a fixed point.

The level of the surfaces of the lochs was obtained by reference to the bench-marks along the shore, but as a rule no correction was made for the variations in the rise and fall of the water while the work was in

progress. Information was collected when possible from local people as to the height of the water in the various lochs in the dry and wet months of the year.

The samples of bottom-deposits were carefully collected by means of the sounding-tube furnished with a flap-valve at its lower end (see Fig. 1), the colour and general appearance being noted, and the samples carefully preserved for future examination.

Serial temperatures were taken in each of the lochs by means of Negretti and Zambra's reversing thermometers, specially adapted for use on the wire-rope of the sounding-machine; observations at the surface of the lochs, and in the streams feeding the lochs, were frequently made as opportunity offered. The pelagic fauna and flora of these lakes were examined by means of fine silk tow-nets, which were dragged through the water at different depths, and the colour and transparency of the water were frequently tested by the submergence of coloured discs.

After the completion of the survey of a particular lake, and when all the soundings had been plotted on the 6-inch Ordnance Survey maps, contour-lines of depth were drawn at definite intervals, and the areas between the consecutive contours were measured by the planimeter, from which the cubic contents and the mean depth of each loch were calculated. The drainage areas of the various lochs (as shown on Map I.) were marked off on the 1-inch Ordnance Survey maps, and the areas between the consecutive contour-lines of height were measured by the planimeter, from which the bulk and the mean height of the land above the level of the lochs were calculated.

Maps and Illustrations.

This paper is illustrated by seven coloured maps. The first three are intended to show the general physical features of the district in which the lochs, treated of in this paper, are situated, and are drawn to a scale of 2 miles to the inch.

Plate I. shows the orography of the district, the height of the land being indicated by different shades of brown, and the depth of the lochs in fathoms by different shades of blue, and the drainage areas of the various lochs are outlined by a distinctive coloured line. It will be observed that the drainage areas form together one compact area, and, indeed, it may be said that (excluding in the mean time Loch Arklet) they are in reality one united drainage system, since Lochs Doine, Voil, and Lubnaig drain into the river Leny, and Lochs Katrine, Achray, Drunkie, and Vennachar drain into the river Teith, which two rivers join above Callander, and flow onwards until they join the river Forth at Stirling, and ultimately empty themselves into the Firth of Forth.

Plate II. shows the surface geology of the district in various colours, and has been prepared from unpublished material collected during the

progress of the Geological Survey of Scotland, revised by Messrs. Peach and Horne, and now published by permission of Sir Archibald Geikie, the Director-General of the Geological Survey of the United Kingdom. A discussion of the geology and glaciation of this district, and of the relation of the depths of the lochs to the surrounding geological features of the country, will be found in the valuable and important geological notes contributed by Messrs. Peach and Horne appended to this paper.

Plate III. shows the mean annual rainfall of the district in different shades of blue, the mean rainfall at the various observing stations being given in heavy black figures. We are indebted to Dr. Alexander Buchan, F.R.S., for information which has enabled us to prepare this map.

The remaining four maps show the details regarding each of the lochs under consideration on a larger scale (3 inches to the mile, 1 : 21,120), on which the majority of the soundings taken during the survey are given in feet, the intervals between the contour-lines of depth being indicated by different shades of blue, and the intervals between the contour-lines of height of the neighbouring country by shades of brown.

Plate IV. shows Loch Katrine and Loch Arklet, the contour-lines of depth being drawn in Loch Arklet at 25 and 50 feet, and in Loch Katrine at 50, 100, 200, 300, and 400 feet.

Plate V. shows Loch Achray, Loch Vennachar, and Loch Drunkie, the contour-lines of depth being drawn in Loch Achray at 25 and 50 feet, the area deeper than 90 feet being indicated by a dotted line; in Loch Vennachar at 25, 50, and 100 feet, and in Loch Drunkie only at 50 feet.

Plate VI. shows Loch Lubnaig, the contour-lines of depth being drawn at 10, 25, 50, 75, and 100 feet.

Plate VII. shows Loch Doine and Loch Voil, the contour-lines of depth being drawn in Loch Doine at 25 and 50 feet, and in Loch Voil at 25, 50, and 75 feet, the area deeper than 90 feet being indicated by a dotted line.

We tender our thanks to J. G. Bartholomew, Esq., F.R.G.S., for the care with which he has supervised the production of these maps, and for valuable advice and suggestions during the progress of the work.

In addition to the maps, there are eleven woodcuts in the text, illustrating the character of the scenery in the vicinity of the lochs, the sounding machine, etc.

Depths of the Lochs.

Loch Katrine.—Loch Katrine is one of the best known and most beautiful of the Scottish lochs. The celebrated woodland scenery of the Trossachs and Ellen's isle is situated at its south-eastern end, while splendid moorland scenery prevails at the north-western end. It has a total length of about 8 miles, with a maximum width of almost exactly

1 mile between the mouths of Letter burn and Strone burn on the northern shore to a small bay on the opposite shore. The mean breadth, obtained by dividing the area of the loch by its length, is 0·6 mile, or 1056 yards, being 7½ per cent. of the length.

The waters of the loch cover an area of 3059 acres (or 4¾ square miles), and it drains an area about eight times greater, or about 24,900 acres (nearly 37½ square miles).* The total number of soundings taken in Loch Katrine was 775, an average of 163 per square mile, and the average depth of these was 142½ feet, the greatest depth observed being 495 feet (82½ fathoms).† The positions of the majority of the soundings are shown on Map IV.

FIG. 3.—LOCH KATRINE AND ELLEN'S ISLE.

(*From a photograph by J. Valentine.*)

The bulk of water contained in the loch is estimated at 27,274,000,000 cubic feet, or about one-fifth of a cubic mile, and the mean depth (supposing the loch to be of uniform depth over its present area) at 199

* When the waters of Loch Arklet are diverted into Loch Katrine this drainage area will, of course, be extended.

† As long ago as September, 1812, and September, 1814, Mr. James Jardine, C.E., recorded observations on the depth and temperature of Loch Katrine (see Buchan, *Proc. Roy. Soc. Edin.*, vol. vii. p. 791, 1872). The maximum depth recorded by him is 480 feet (80 fathoms), whereas, as stated above, we found a depth of 495 feet. His temperature observations are given in the table of serial temperatures, and discussed along with the recent observations. We believe that Mr. J. Y. Buchanan took soundings and temperatures in Loch Katrine some years ago, but, as far as we are aware, they were never published, and are therefore not available for discussion (see also Art. "Lake" in *Encycl. Brit.*, 9th edit.).

feet (33 fathoms), the mean depth being over 40 per cent. of the maximum depth. The length of the loch is 85 times the maximum depth, and 211 times the mean depth.

FIG. 5.—CROSS-SECTION OF LOCH KATRINE. THE BLACK PORTION SHOWS THE TRUE SLOPES; THE OUTLINE SHOWS THE SLOPES EXAGGERATED TEN TIMES.

The surface of the loch is, according to the Ordnance Survey maps, at an elevation of 364 feet above sea-level, so that our survey shows that a considerable portion of the bottom of the loch (equal to about 645 acres, or over one square mile) lies below sea-level, the deepest part being 131 feet (or 22 fathoms) below the level of the sea. The area below the level of the sea is indicated by a red line on Map IV. In this respect Loch Katrine differs from the other lochs referred to in this paper, for in none of them is the depth sufficiently great to bring any portion of their bottoms below the level of the sea.

The soundings show that Loch Katrine practically forms a single basin, not being divided, like Loch Lomond and Loch Lubnaig, for instance, into separate basins by any important ridges or rises on the bottom. The deepest part is in the centre of the loch, a long narrow depression, with depths exceeding 400 feet, extending for over 4 miles from opposite Coilachra to opposite Ruinn Dubh-aird, with a maximum width of over a quarter of a mile; this 400-feet depression has an area of about 515 acres, or 17 per cent. of the entire superficial area of the loch. The deepest sounding (495 feet) is situated at the very eastern extremity of the 400-feet depression.

The 300-feet depression is over 5 miles in length, with a maximum breadth of one-third of a mile; it extends from off Coilachra to near Ellen's isle. The area enclosed between the 300-feet and 400-feet contour-lines is about 415 acres, or 13 per cent. of the entire area of the loch.

The 200-feet depression is 5½ miles in length and half a mile in maximum breadth, extending from south of Ellen's isle to near Black island, where it is separated (by a sounding of 198 feet) from a small isolated area, lying between Coilachra and

FIG. 4.—LONGITUDINAL SECTION OF LOCH KATRINE, ALONG THE AXIS OF MAXIMUM DEPTH. THE BLACK PORTION SHOWS THE TRUE SLOPES; THE OUTLINE SHOWS THE SLOPES EXAGGERATED TEN TIMES.

Black island, one-third of a mile in length by nearly one-eighth of a mile broad. The area between the 200- and 300-feet contours is about 510 acres, or 17 per cent. of the area of the loch.

There are two 100-feet depressions, the principal one (6 miles in length) stretching from close to Ellen's isle to Black island, the other extending from Black island towards the point called Rudha nam Moine, with a total length of over half a mile. The area enclosed between the 100- and 200-feet contours is about 670 acres, or 22 per cent. of the area of the loch.

The 50-feet line follows pretty closely the contour of the loch, from Rudha nam Moine into the eastern arms of the loch at the Trossachs,

FIG. 6.—LOCH ARKLET, LOOKING WEST.
(*From a photograph by G. W. Wilson.*)

running outside of Black island, Ellen's isle, and the small islands near the shore all round, with a small isolated patch at the junction of the Trossachs arm with the arm leading to Achray Water; it encloses a small shallow, with a beacon on it, opposite the entrance of the Glasahoile. The area between the 50- and 100-feet contours is about 400 acres, or 13 per cent. of the area of the loch, while the area between the coast-line and the 50-feet contour is nearly 550 acres, or 18 per cent. of the area of the loch, so that 82 per cent. of the floor of the loch is covered by over 50 feet of water.

Loch Arklet.—At the present time Loch Arklet drains into Loch Lomond, but the corporation of the city of Glasgow have power, by the

erection of a dam at its west end, to divert the waters into the catchment-basin of Loch Katrine, in order to increase the supply of water to the city. The surface of this little moorland loch is, according to the Ordnance Survey maps, 455 feet above sea-level. It has a total length of over a mile, and a maximum width near the east end of nearly half a mile. The mean breadth is about one-third of a mile, or 587 yards, being 33 per cent. of the length. Its waters cover an area of about 210 acres (0·3 square mile), and it drains an area about sixteen times greater, or about 3400 acres (5⅓ square miles). The number of soundings taken in Loch Arklet (see Map IV.) was 135, the average depth of these being 21 feet, and the greatest depth observed being 67 feet (11 fathoms). The mass of water in the loch is estimated at 222,000,000 cubic feet, and the mean depth at 24 feet, or 36 per cent. of the maximum depth. The length of the loch is 79 times the maximum depth, and 218 times the mean depth.

The wide eastern portion of Loch Arklet is shallower than the narrower western portion. The 50-feet depression extends little more than halfway towards the eastern end of the loch, and is slightly under half a mile in length, the greatest depth (67 feet) being approximately near the centre of the depression, and nearer the western than the eastern end. The area over 50 feet in depth is estimated at about 19 acres, or 9 per cent. of the area of the loch, while the area between the 50-feet line and the shore is about 191 acres, or 91 per cent. of the entire superficial area.

Two small islands appear on the chart in the shallower part of the loch towards the north-eastern end.

Loch Achray.—This pretty little lake is situated at the entrance to the Trossachs, and immediately before the windows of the Trossachs Hotel. Loch Achray, the surface of which is, according to the Ordnance Survey maps, 276 feet above sea-level, has a total length of about 1¼ miles, with a maximum width of nearly one-third of a mile. The mean breadth is about a quarter of a mile, or 458 yards, being nearly 21 per cent. of the length. Its waters cover an area of about 205 acres (one-third of a square mile), and the area draining into it is twenty-two times greater, or about 4500 acres (7 square miles). The number of soundings taken in Loch Achray (see Map V.) was 171, and the average depth of these was 36½ feet, the maximum depth recorded being 97 feet (16 fathoms). The bulk of water contained in the loch is estimated at 321,000,000 cubic feet, and the mean depth at 36 feet (6 fathoms), or 37 per cent. of the maximum depth. The length of the loch is 68 times the maximum depth, and 183 times the mean depth.

The 50-feet depression is over two-thirds of a mile in extreme length, with a maximum width of about one-fifth of a mile, lying uniformly near the centre of the loch, and covers an area of about 64 acres, or 31 per

cent. of the superficies of the loch. Within this area there is a depression occupying about 32 acres where the depths exceed 90 feet, the greatest registered depth (97 feet) being recorded in two places approximately in the centre of the loch. At the west end of the loch, not far from the hotel pier, a detached sounding of 50 feet is recorded; off the mouth of the Achray water there are some shallow patches, and a shallow in the centre of the loch towards the west end, on which there are 2 to 3 feet of water, is marked by a beacon. The area less than 50 feet in depth is estimated at about 141 acres, or 69 per cent. of the total area of the loch. The eastern end of the loch is relatively shallow; at one place there is a depression with 27 feet surrounded by shallower water, and at another

FIG. 7.—LOCH ACHRAY, LOOKING WEST TOWARDS BEN VENUE.
(From a photograph by J. Valentine.)

place there is what appears to be a submerged crannog covered by only 1 or 2 feet of water.

Loch Vennachar.—Loch Vennachar, the surface of which is, according to the Ordnance Survey maps, 270 feet above sea-level, has a total length of about 4 miles, with a maximum width of less than three-quarters of a mile. The mean breadth is about two-fifths of a mile, or 704 yards, being 10 per cent. of the length. Its waters cover an area of about 1030 acres (or over $1\frac{1}{2}$ square miles), and it drains an area nearly eighteen times greater, or about 18,300 acres ($28\frac{1}{2}$ square miles). The total number of soundings taken in Loch Vennachar (see Map V.) was 423, an average of 263 per square mile, the average depth of these being

41 feet, and the greatest depth observed being 111 feet (18½ fathoms), so that it may be regarded as a relatively shallow loch. The bulk of water contained in the loch is estimated at 1,903,000,000 cubic feet, and the mean depth at 42½ feet (7 fathoms), being 38 per cent. of the maximum depth. The length of the loch is 190 times the maximum depth, and 498 times the mean depth.

It will be observed from an examination of the map that the loch is deeper in the eastern than in the western portion, the western end being shallow and covered with weeds, so that one must proceed nearly a mile from the west end of the loch before encountering depths of 50 feet, and this is merely a small patch separated from the principal 50-feet depression by a distance of nearly two-thirds of a mile. In August the water in the loch is at its lowest, and the weeds at the west end most abundant. The principal 50-feet depression is about 2 miles in length, with

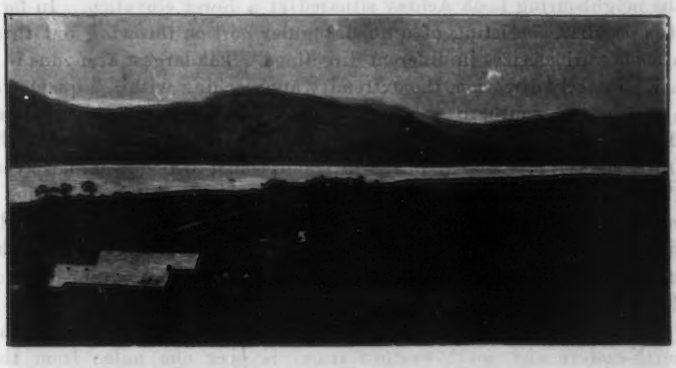

FIG. 8.—LOCH VENNACHAR, LOOKING SOUTH-WEST.
(From a photograph by G. W. Wilson.)

a mean breadth of about one-third of a mile and a maximum breadth of nearly half a mile. It includes two 100-feet depressions: the first one is very irregular in shape, situated approximately in the centre of the loch, and contains the greatest observed length (111 feet), which lies towards the northern shore; the second one occupies the central portion of the large 50-feet depression, the greatest depth observed therein being 106 feet. Towards the eastern end of the large 50-feet depression is a small shallow patch in the centre of the loch opposite Portnellan, in which a depth of 36 feet was found.

At the extreme eastern end are situated the sluices and weir, over which the compensation water passes into the river Teith; at some distance from the sluices the depth of water flowing over a weir is recorded twice a day.

The area between the shore and the 50-feet contour is estimated at about 635 acres, or 62 per cent. of the entire superficial area of the loch, while the area between the 50- and 100-feet lines is estimated at about 324 acres, or 31 per cent., and the area with depths over 100 feet is estimated at about 71 acres, or 7 per cent. of the area of the loch.

Loch Drunkie.—This picturesque and irregular Highland loch is shut in on all sides by high hills, is difficult of access, and rarely visited. The surface of the loch, according to the Ordnance Survey maps, is 416 feet above the level of the sea, but it was raised 25 feet in connection with the water-supply to the city of Glasgow, with the view of furnishing compensation water to the river Teith. The soundings shown on the map give the depth of the loch in April, 1899.

Loch Drunkie is remarkable in many respects. It is the smallest of the five lochs in the Loch Katrine district, but deeper than the larger Loch Arklet situated at a similar high elevation, and quite as deep as the neighbouring Loch Achray situated at a lower elevation. In form it is peculiar, consisting of a quadrangular portion throwing out three arms of various sizes in different directions. The largest arm runs in a north-easterly direction, the extremity approaching within a quarter of a mile of the southern shores of Loch Vennachar; this arm contains the greatest depths observed in the loch, and near its extremity the Ordnance Survey map indicates a small island which was not seen. The second arm in point of size runs directly west, and contains a maximum depth of 80 feet. The smallest arm runs in a south-westerly direction, deepening gradually though irregularly from 6 feet at the extremity to 15 feet near the junction with the quadrangular body of the loch.

The maximum length of the loch (between the extremities of the north-eastern and south-western arms) is over one mile; from the extremity of the western arm to the opposite (eastern) shore of the loch is a little less. The maximum width of the quadrangular body of the loch is over a quarter of a mile. The mean breadth is 0·21 mile, being 21 per cent. of the length. The waters of the loch cover an area of about 138 acres (0·22 square mile), and drains an area ten times greater, or over 1400 acres (2·2 square miles). The number of soundings taken in Loch Drunkie (see Map V.) was 155, the average depth of these being 38½ feet, the greatest depth observed (exactly the same as in the case of Loch Achray) being 97 feet (16 fathoms). The bulk of water contained in the loch is estimated at 217,000,000 cubic feet, and the mean depth at 36 feet (or 6 fathoms), being 37 per cent. of the maximum depth. The length of the loch is 54 times the maximum depth, and 147 times the mean depth.

There are two depressions with depths over 50 feet: one at the extremity of the western arm, about a quarter of a mile in length, and the other filling up the greater part of the body of the loch, and

extending some distance up the north-eastern arm, being over one-third of a mile in length and about one-quarter of a mile in maximum width. The area over 50 feet in depth is estimated at 43 acres, or 31 per cent. of the total area of the loch, while the area between the shore and the 50-feet contour is estimated at 95 acres, or 69 per cent. of the area of the loch.

Lochs Voil and Doine.—These two lochs, the surfaces of which, according to the Ordnance Survey maps, are situated at an elevation of 414 feet above sea-level, formed at no very distant date a continuous loch, which has been divided into two portions principally by the deposition of material brought down Monachyle glen by the river; this

FIG. 9.—LOCHS VOIL AND DOINE, LOOKING WEST FROM ROB ROY'S GRAVE, BALQUHIDDER.
(*From a photograph by J. Valentine.*)

is supported by the fact that deep water extends close up to the dividing promontory of land on both sides. The former continuous loch must have been over 4½ miles in length. As the level of these two lochs is 50 feet higher than the level of Loch Katrine, it has been suggested by Mr. Gale that the water-supply to the city of Glasgow could, if necessary, be increased by connecting these lochs to Loch Katrine by a conduit through the intervening hills.

Loch Voil.—Loch Voil has a total length of over 3½ miles, with a maximum width (near the western end) of about one-third of a mile. The mean breadth is about a quarter of a mile, or 422 yards, being 7 per cent. of the length. The waters of Loch Voil cover an area of

about 561 acres (0·88 square mile), and those of Loch Doine about 135 acres (0·21 square mile), or together over one square mile, while they drain an area thirty-five times greater, or about 24,600 acres (nearly 38½ square miles).

The total number of soundings taken in Loch Voil (see Map VII.) is 279, the average depth of these being 39½ feet, and the greatest depth 98 feet (or 16⅓ fathoms). The bulk of water contained in the loch is estimated at 1,000,000,000 cubic feet, and the mean depth at 41 feet (or nearly 7 fathoms), being 42 per cent. of the maximum depth. The length of the loch is 189 times the maximum depth, and 451 times the mean depth.

Loch Voil becomes narrower and shallower towards the eastern end; one must proceed about a mile and a half (or over one-third of the length of the loch) from the eastern end before encountering depths of 50 feet, while deeper water is found towards the western end. The 50-feet depression extends from quite close to the western end for a distance of 2 miles towards the eastern end of the loch, with a maximum width of about a quarter of a mile. Towards the western end of the loch is a considerable area (over half a mile in length by a sixth of a mile in maximum breadth) having depths greater than 90 feet. In this all the deepest soundings are situated (the greatest depth, 98 feet, having been observed in two places). From this depression the bottom of the loch apparently rises very gradually towards the eastern end.

The area over 50 feet in depth is estimated at about 230 acres, or 41 per cent. of the entire area of the loch, while the area between the shore and the 50-feet line is estimated at about 331 acres, or 59 per cent. of the total extent of the loch.

Loch Doine.—Loch Doine has a total length of nearly one mile, with a maximum width of over a quarter of a mile; the mean breadth is about 0·21 mile, or 370 yards, being 21 per cent. of the length. The total number of soundings taken in Loch Doine (see Map VII.) was 90, the average depth of these being 34¾ feet, the greatest depth being 65 feet (11 fathoms). The bulk of water contained in the loch is estimated at 196,000,000 cubic feet, and the mean depth at 33 feet (5½ fathoms). The length of the loch is 81 times the maximum depth, and 160 times the mean depth.

In Loch Doine the deeper water occupies approximately the centre of the loch, the deepest soundings (65 feet) being found, however, nearer the eastern than the western end of the loch. The 50-feet depression covers over one-third of the area of the loch, being about three-quarters of a mile in length with a maximum width of over one-eighth of a mile. It seems doubtful whether this 50-feet depression is not really separated into a larger and a smaller portion, for the narrow neck shown on the map is founded upon a single sounding of exactly 50 feet. The greatest depth, 65 feet, was observed in several spots situated towards the

eastern end of the loch. The area with depths over 50 feet is estimated at 47 acres, or 35 per cent. of the entire area of the loch, while the area with depths less than 50 feet is estimated at 88 acres, or 65 per cent. of the area of the loch.

Loch Lubnaig.—The outflow from Lochs Doine and Voil passes by the river Balvag, 5 miles in length, into Loch Lubnaig, the surface of whose waters is, according to the Ordnance Survey maps, 405 feet above sea-level, or 9 feet lower than that of the other two lochs. A consideration of the intervening ground indicates that in post-glacial times these three lochs formed one single sheet of water.

FIG. 10.—LOCH LUBNAIG, LOOKING NORTH.
(From a photograph by G. W. Wilson.)

Loch Lubnaig has a total length of nearly 4 miles, following approximately a line drawn down the centre of the loch, with a maximum width of about two-fifths of a mile. The mean breadth is nearly a quarter of a mile, or 422 yards, being 6 per cent. of the length. Its waters cover an area of about 614 acres (or nearly 1 square mile), and it drains an area 36½ times greater, or about 22,400 acres (nearly 35 square miles). The total number of soundings taken in Loch Lubnaig (see Map VI.) was 394, the average depth of these being 20½ feet, and the greatest depth observed 146 feet (24⅓ fathoms). The bulk of water contained in the loch is estimated at 1,144,000,000 cubic feet, and the mean depth at 42¾ feet (or 7 fathoms), being 29 per cent. of the maximum depth. The length of the loch is 145 times the maximum depth, and 493 times the mean depth.

Loch Lubnaig differs from the other lochs in the neighbourhood in that it does not constitute a single basin. The bottom is apparently very irregular; the contour-lines of depth do not follow the contour of the loch, hollows and ridges alternate with each other, and in some places comparatively deep water is found close to the shore, while in other places shallow water extends a considerable distance from shore. The loch is also, comparatively speaking, very narrow and shallow considering its size, nearly two-thirds of the area being under 50 feet in depth. The loch may be conveniently divided into two halves, defined by the central constriction in the outline of the loch at the entrance of the Ardchullarie burn, where the bottom shallows and separates the two principal deep depressions; the northern half trends in a north-west and south-east direction, while the southern half trends almost directly north and south.

There are two depressions in which the depth exceeds 100 feet, with an isolated sounding of 106 feet between them. The larger depression is contained in the southern half of the loch, and is over half a mile in length, with a maximum width of about one-sixth of a mile; the greatest depth in this depression is 118 feet. The smaller but deeper depression is situated at the base of the northern half of the loch, occupying a central position, and is over a quarter of a mile in length, with a maximum width of about one-sixth of a mile. The deepest sounding in the loch (146 feet) is centrally placed in this depression, lying north-westward of the point where the Ardchullarie burn enters the loch. The area over 100 feet in depth is estimated at about 55 acres, or 9 per cent. of the entire area of the loch.

There are three depressions in which the depth exceeds 50 feet. The largest is contained in the southern half of the loch, and is over 1½ miles in length, with a maximum width of over a quarter of a mile. The second in point of size is centrally placed, and is over half a mile in length, with a maximum width of over a quarter of a mile. The third and smallest (and also the shallowest, the deepest sounding in it being 62 feet) is situated near the northern end of the loch, and is little more than a quarter of a mile in length and about one-eighth of a mile in greatest width. At the upper end of the loch, where the river Balvag enters, there is a long spit formed of detritus brought down by the river, and this end of the loch for a distance of three-quarters of a mile is very shallow, while at the lower end the 50-feet contour is found within 200 yards of the outlet. The area between the 50-feet and 100-feet contours is estimated at about 162 acres, or 26 per cent. of the total area of the loch, while the area with depths under 50 feet is estimated at about 397 acres, or 65 per cent. of the area of the loch.

When the loch was visited on April 6, 1899, it appeared from marks on the shore that the water had lately been 4 feet 10 inches higher than at that time, and it has been known to have been 12 or 18 inches lower,

so that the rise and fall is about 6 feet in all. On one occasion a disc was visible down to a depth of 17½ feet, and on another down to 20½ feet.

On the western shore, between 1¼ and 1½ miles from the southern end of the loch, there is a remarkable sandy spit, which stretches out towards the centre of the loch, the origin of which appears to us somewhat puzzling (see the Geological Notes by Messrs. Peach and Horne).

The details regarding the different lochs have been collected together in the table on p. 330 for convenience of reference and comparison.

Deposits.

As a general rule, the materials forming the deposits in these fresh-water lochs become finer grained the further from the shore and the deeper the water. Off the mouths of rivers and burns there is frequently a considerable accumulation of gravel and fine sand, extending for some distance into the lake and occasionally reaching rather deep water. Large stones, gravel, and sand are usually found all round the shores within the limits of wave-action. The height and length of the waves, and the depth to which wave-action extends, depend on the size and depth of the loch.

The central parts of the lochs are occupied by a fine impalpable mud, which is found in its most characteristic form in the greater depths far from shore; it is usually of a light or dark brown colour, and sometimes there are indications of different-coloured layers. The usual mineral species are quartz, felspars, black and white mica, amphibole, pyroxene, magnetite, garnets, etc. Chemical analysis showed that these fine muds contained no appreciable calcareous matter, but traces of sulphuretted hydrogen were always present. The loss on ignition after drying at 90° C., due to organic matter and combined water, varied from 13 to 26 per cent. Diatoms were observed in nearly all the samples, and vegetable fibre was usually present in greater or less abundance.

The samples from the deepest part of Loch Katrine were brownish, fine-grained, homogeneous muds, with glittering mica-flakes, consisting principally (50 to 70 per cent.) of angular mineral particles exceeding 0·05 mm. in diameter, the mean diameter being about 0·15 mm., with clayey and vegetable matter, and many minute mineral particles less than 0·05 mm. in diameter. A few diatoms were observed, and one sample, after drying at 90° C., gave 19·91 per cent. loss on ignition.

The mud from the deepest part of Loch Achray was of a grey-brown colour, containing much vegetable and clayey matter, the mineral particles exceeding 0·05 mm. in diameter making up probably 30 or 40 per cent. of the whole deposit. Some fine diatoms were observed, and the loss on ignition, after drying at 90° C., amounted to 12·84 per cent.

The mud from a depth of 102 feet in Loch Vennachar was yellowish-brown in colour, containing about 20 per cent. of mineral particles with

Loch.	Elevation of surface above the sea.	Number of soundings.	Length.	Breadth, miles.		Mean breadth per cent. of length.	Depth.			Ratio of depth to length.		Volume, million cubic feet.	Area of loch.	Drainage area.	
							Feet.		Mean per cent. of max.						
	Feet.		Miles.	Max.	Mean.		Max.	Mean.		Max.	Mean.		Square miles.	Total in square miles.	Ratio to area of loch.
Katrine ...	364	775	8·00	1·00	0·60	7·5	495	199·189	40·4	85	211	27,274	4·78	37·42	7 83
Arklet	455	135	1·00	0·50	0·33	33 3	67	24·190	36·1	79	218	222	0 33	5·33	16·15
Achray ...	276	171	1·25	0·33	0·26	20·8	97	36 009	37 1	68	183	321	0 32	7·06	22·06
Vennachar ...	270	423	4·00	0·75	0·40	10·0	111	42·410	38·2	190	498	1,903	1·61	28·65	17·80
Drunkie ...	416	155	1·00	0·25	0·21	21·0	97	36·050	37·1	54	147	217	0·22	2·20	10 00
Voil	414	279	3·50	0·33	0·24	6 9	98	40·936	41·8	189	451	1,000	0 88	38·47	35 29
Doine	414	90	1 00	0·25	0·21	21·0	65	33·130	51·0	81	160	196	0 21		
Lubnaig ...	405	394	4·00	0·40	0·24	6·0	146	42·773	29·3	145	493	1,144	0·96	34·97	36 43
		2122										32,277	9·31	154·10	16·55

a mean diameter of 0·1 mm., but principally made up of amorphous clayey matter with vegetable matter, and many minute mineral particles less than 0·05 mm. in diameter. There were a few diatoms; the loss on ignition, after drying at 90° C., amounted to 14 per cent.

The mud from the deeper part of Loch Drunkie was of a dirty brown colour, containing 10 to 20 per cent. of mineral particles with a mean diameter of 0·1 mm., but consisting principally of amorphous clayey matter, with many small mineral particles, and vegetable matter. A few diatoms were observed. The loss on ignition, after drying at 90° C., amounted to 26·38 per cent.

The deposit from the deeper parts of Loch Arklet was similar to that from Loch Drunkie, with even a larger quantity of vegetable matter.

The mud from the deeper parts of Lochs Doine and Voil was of a brown colour, with 30 to 40 per cent. of mineral particles, and clayey and vegetable matter, and a few diatoms. A sample from a depth of 80 feet in Loch Voil, after drying at 90° C., gave 22·74 per cent. loss on ignition.

The material from a depth of 136 feet in Loch Lubnaig was a brown impalpable mud, with 30 to 40 per cent. of mineral particles, much clayey and vegetable matter, and a few diatoms. The loss on ignition, after drying at 90° C., amounted in one sample to 16·29 per cent., and in another sample to 15·76 per cent.

Temperature Observations.

During the various visits to the different lochs, many observations were made on the temperature of the water, both on the surface and at intervals below the surface, down to the bottom. All the serial temperatures taken by us have been collected together in the table on p. 332,* and, in order to make the record more complete, the temperatures taken by Jardine in 1812 and 1814 in Loch Katrine are given in the first two columns.

Loch Katrine.—The surface temperatures taken in Loch Katrine during the seven days from June 5 to 11, 1897, are extremely interesting, as illustrating the effect of the wind. The range of temperature during this time was 12½°, from 45·3° to 57·8°, the highest reading being observed at Trossachs pier on the evening of June 5, and the lowest at the same place on the evening of June 9. This was evidently the result of a strong east wind, which commenced to blow on the 6th, and continued from the same direction till the 9th, blowing the warm surface-waters before it from the east towards the west end of the loch, while colder water from below was drawn up to the surface at the east end of the loch to take its place. The gradual cooling of the water at

* Temperature observations in the surface-waters of some of the lochs under consideration have been taken by Mr. Thomas Scott, and the results published in the *Annual Reports of the Fishery Board for Scotland.*

Depth in fathoms.	Loch Katrine.							Loch Arklet.	Loch Achray.	Loch Drunkie.	Loch Vennachar.		Loch Doine.		Loch Voil.			Loch Lubnaig.
	Jardine. Sept. 7, 1812.	Jardine. Sept. 3, 1814.	June 6, 1897.	June 9, 1897.	Nov. 26, 1897.	June 9, 1898.	Apr. 15, 1899.	June 11, 1897.	June 12, 1897.	June 12, 1897.	June 10, 1897.	Apr. 11, 1899.	July 7, 1897.	Apr. 10, 1899.	July 7, 1897.	July 7, 1897.	Apr. 10, 1899.	Apr. 8, 1899.
	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°	°
Surface	57·9	56·8	55·9	—	47·4	55 0	41·2	55·4	57·5	57·0	55·8	42·6	54·0	{42·0 / 42·6}	56 0	55·0	42·0	42 0
1	—	—	—	—	47·4	—	41·2	—	—	—	—	—	—	42·6	—	—	—	—
2	—	—	—	—	—	—	—	—	—	—	—	42·5	—	—	—	—	—	—
3	—	—	—	—	47·4	—	—	—	—	—	—	—	—	—	55·3	—	—	—
5	—	56·7	48 4	52·0	47·4	54·0	42·0	54·4	53·5	52·6	53·3	42·5	53·4	42·1	—	54·0	42·1	42·7
8	—	—	—	—	—	—	—	—	—	—	—	—	—	—	55·3	—	—	—
10	50·9	49·6	44·0	—	47·3	47 8	41·9	—	—	—	48·2	42·5	52·1	{42·0 / 41·8}	—	—	42·0	41·9
15	—	45·5	—	—	47·4	—	—	—	—	—	47·2	42·7	—	—	—	—	—	42·6
16	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	54·5	—	—
18	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	42·6
20	43·5	44·4	42·0	—	47·4	44·0	42·0	—	—	—	—	—	—	—	—	—	—	41·8
23	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	41·8
25	—	43·3	—	—	46·8	—												
30	—	42·3	42·5	—	46·0	43·5												
35	41·5	—	—	—	43·5	—												
40	—	—	41·5	—	43·8	42 6												
45	—	—	—	—	42·9	—												
50	41·5	—	42·2	—	43 2	—												
55	—	—	—	—	42·5	—												
60	41·5	—	41·5	—	—	—												
66	—	—	—	—	—	42·8												
76	—	—	—	—	—	42·0												
80	41·4	41·7	—	—	43·0	—												
82½	—	—	—	—	43·8	—												

the east end of the loch is well shown by the temperatures taken at Trossachs pier from day to day: thus at 6.30 p.m. on June 5 the temperature was 57·8°; at 11.30 a.m. on the 6th it was 56·2°, and at 4 p.m. 55·3°; at 7 a.m. on the 7th it was 49·2°; at 10.30 a.m. on the 8th it was 46·3°; and at 7.15 p.m. on the 9th it was 45·3°. By 9.30 a.m. on the 11th it had risen again to 50·1°. The effect of the wind was also shown by a series of surface-temperatures taken from the steamer on its way from Stronachlachar pier to the Trossachs pier on the evening of June 9: thus at Stronachlachar the temperature was 52·6°; near the waterworks,

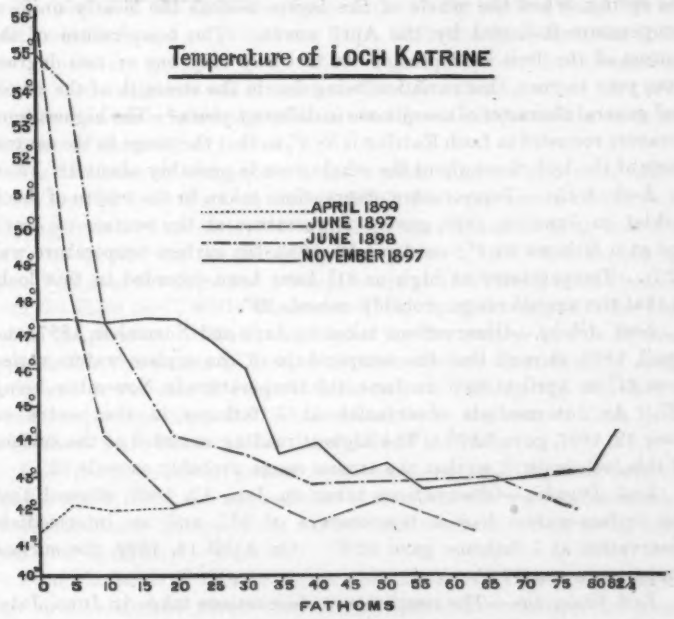

FIG. 11.—CURVES OF TEMPERATURE IN LOCH KATRINE.

52·0°; near Letter, 49·6°; near Brenachoil, 48·8° and 48·0°; near Ellen's isle, 47·4° and 47·0°; and finally at Trossachs pier, 45·3°. It will thus be seen that it is very unsafe to rely on a single observation at one spot, as giving a sure indication of the temperature of the surface-waters of a loch as a whole at any given season. A year later (from June 4 to 9, 1898) the temperature of the surface-waters of Loch Katrine was not observed to fall below 50°. On November 26, 1897, the surface-temperature varied only from 46·8° to 47·4°, and on April 13 and 15, 1899, from 41·2° to 42·7°.

The serial temperatures in Loch Katrine are shown graphically in the accompanying curves (Fig. 11), which exhibit the march of

temperature in the waters of the loch throughout the year. The curve for April shows that the water from top to bottom has a temperature ranging between 41° and 42° Fahr. In the two curves for June the heating effect of the sun on the surface-layers is indicated, but in depths beyond 20 fathoms the temperature has not been appreciably effected. In June, 1898, the whole body of water in the loch was apparently slightly warmer than in the previous June. The November curve shows a great accumulation of summer heat in the layers down to depths of 30 and 35 fathoms. By this time cooling has set in, and progresses slowly until the spring, when the whole of the layers assume the nearly uniform temperature indicated by the April curve. The temperature of the bottom of the loch in depths of 400 feet may vary one or two degrees from year to year, this variation being due to the strength of the winds and general character of the climate in different years.* The highest temperature recorded in Loch Katrine is 58·4°, so that the range in the central parts of the loch throughout the whole year is probably about 18° Fahr.

Loch Arklet.—Temperature observations taken in the centre of Loch Arklet on June 11, 1897, gave a temperature at the surface of 55·4°, and at 5 fathoms 54·4°; on April 13, 1899, the surface-temperature was 42·7°. Temperatures as high as 61° have been recorded in this loch, so that the annual range probably exceeds 29°.

Loch Achray.—Observations taken in June and November, 1897, and April, 1899, showed that the temperature of the surface-waters varied from 41° in April to 59·5° in June, the temperature in November being 46°. An intermediate observation at 5 fathoms in the centre on June 12, 1897, gave 53·5°. The highest reading recorded at the surface of this loch is 64·1°, so that the annual range probably exceeds 32°.

Loch Drunkie.—Observations taken on June 12, 1897, showed that the surface-waters had a temperature of 57°, and an intermediate observation at 5 fathoms gave 52·6°. On April 14, 1899, the surface temperature was 42·4°.

Loch Vennachar.—The temperature observations taken in June, July, and November, 1897, and April, 1899, showed that the temperature of the surface-water varied from 41° in April to 56·5° in June, the temperature in November being 46° to 47°, while the water of Blairgarry stream had a temperature of 42·2°. Serial observations in the centre of the loch on June 10, 1897, showed a gradual fall in the temperature from 55·8° at the surface to 47·2° at 15 fathoms; while on April 11, 1899, the temperature was practically uniform from surface to bottom at 42·5° to 42·7°.

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* See Murray, "Some Observations on the Temperature of the Water of the Scottish Fresh-water Lochs" (*Scottish Geographical Magazine*, vol. xiii. p. 1, 1897). At noon on March 10, 1900, in calm and frosty weather, the temperature of the surface-water of Loch Katrine, over the deepest part of the loch, was 40·3°, at 10 feet 40·2°; at all other depths down to 492 feet the temperature-readings were 40·0° and 40·1°. On the same date the readings in shallow water were 39·4°.

Loch Doine.—Observations taken on July 7, 1897, and April 10, 1899, showed that the temperature varied from 42° in April to 54° in July. Serial observations in the centre of the loch in July gave a temperature at the surface of 54°, falling to 52·1° at 10 fathoms, while in April the temperature was found to be nearly uniform from surface to bottom, ranging from 41·8° to 42·6°.

Loch Voil.—Observations taken in July, 1897, and April, 1899, showed that the temperature of the surface-water varied from 41·2° in April to 56·5° in July. Serial observations taken on July 7, 1897, showed that in the centre of the loch the temperature at the surface was 55·0°, at 5 fathoms 54·0°, and at 16 fathoms 54·5°, while further down the loch the temperature appeared to be rather higher, viz. 56·0° at the surface, and 55·3° at 3 fathoms and 8 fathoms. Serials taken on April 10, 1899, showed that the whole body of water was practically uniform in temperature at about 42°.

For the sake of comparison a few surface-temperatures were taken at the head of Loch Earn on July 6, 1897, the temperature of the loch varying from 48·8° to 49·2°, while that of the streams flowing into the loch was 52·2°. On the following day (July 7, 1897) the surface of Loch Voil near the shore had a temperature of 56·4°, and a little distance from the shore 54·6°, while the water of the burn flowing into the loch had a temperature of 53·6°, and higher up the stream 53·1°. It thus appears that the waters of Loch Voil were warmer than those of Loch Earn, and in the case of Loch Voil the stream feeding the loch had a lower temperature than the loch itself, while in the case of Loch Earn the streams were warmer than the waters of the loch.

Loch Lubnaig.—Observations were taken in Loch Lubnaig only on April 6 and 8, 1899, and showed that at that time the temperature of the water was nearly uniform from surface to bottom, the range being only from 41·8° to 42·7°.

From the point of view of temperature, the Scottish fresh-water lochs may be divided into those which freeze during hard winters, and those which never freeze. Those which freeze over in winter are shallow lochs, and when frozen the water-temperature beneath the ice is at the maximum density point of fresh water (39·1°) or lower. In spring the temperature of these shallow lochs rises much more quickly through the heat of the sun, and the whole mass of water attains a higher temperature than in the case of the deeper lochs; they also lose their heat much more quickly in the autumn than the deep lochs, and consequently have a much wider range of annual temperature. In the deep lochs—those with 400 or more feet of depth—the temperature of the water never rises so high in summer, nor sinks so low in winter, as in the shallow lochs, and the range is much less. The temperature of the bottom water in some cases does not change more than 1° Fahr. from year to year, and in the deepest lochs it appears to be practically

constant at all times and seasons; 40° is the lowest temperature that has been recorded at the bottom in any of these deep Scottish lochs, so that the maximum density point is never reached. In summer, autumn, and even early winter, it is possible, by observing the temperature of the surface and sub-surface waters, to form a fairly accurate idea of the depth of a loch, the temperature being higher the shallower the loch. The waters from a deep loch—like Loch Katrine—are much the best for the water-supply to a city, for in summer the temperature is relatively low and in winter it is relatively high.

Pelagic and Other Organisms.

Tow-net and other observations show that the nature and amount of the organic life in the fresh-water lochs are subject to great variation in the different lochs when compared with each other, and in the same loch at different seasons of the year. Large numbers of observations are being collected, and we may look for interesting results when these are in a state for discussion. Generally speaking, the pelagic fauna and flora are much more abundant in the warm summer months than at other times of the year, and are also more abundant in the shallow lochs than in the deep ones. In the spring months there is a great development of diatoms and other Phytoplankton, which render the water less transparent than at other times of the year.

Mr. Thomas Scott has lately been comparing the fauna in several of the Scottish lochs at different seasons of the year; some of his results for the lochs now under consideration may be noted.

In Loch Katrine the Entomostraca and other invertebrates were scarcer than in the other lochs examined. Fourteen species are recorded, *Bosmina longispina* being the only species present in all the gatherings; *Leptodora* was entirely absent from the gatherings collected during the colder months. *Cyclops strenuus* and *Polyphemus* appeared to be more frequent in the upper part of the loch, and *Bosmina* and *Leptodora* in the lower part. The sides of Loch Katrine do not generally present conditions very favourable to shore-dwellers, and an examination of the shore about Stronachlachar yielded scarcely anything that differed from the tow-net captures, while at the lower end the shore between the Trossachs pier and Ellen's isle yielded much better results. Here forty species of Crustacea were obtained, as well as one or two species of Mollusca, but they were all individually scarce. The Cladocera were more numerous in species in the warmer than in the colder months, while with the Copepoda the reverse was observed, though the difference was not so great.*

In Loch Arklet, *Holopedium gibberum*, one of the most remarkable species of the Cladocera in Britain, was moderately common in the

* Scott, *Seventeenth Annual Report of the Fishery Board for Scotland*, pt. iii. pp. 148-151, 1899.

tow-net gatherings collected in September and November, 1897, and in June, 1898, it was abundant all through the water, but when the loch was visited in March, 1898, not a trace of *Holopedium* could be seen. In June, when *Holopedium* was so abundant, other species previously observed were either very scarce or absent, as if they had been more or less crowded out by this particular cladoceran. Eleven crustacean species are recorded, *Daphnia* being the only form obtained in all the gatherings; *Bythotrephes* was observed in September and June, but not in November and March, and *Leptodora* occurred only in September. Infusoria (*Ceratium*, etc.) and micro-algæ were much less frequent in June than in the other gatherings. Forty-two species of Entomostraca were obtained by hand-net round the shores of Loch Arklet, including a few comparatively rare forms; very few molluscs were observed in any of the gatherings.*

Twelve species of Entomostraca were captured by the tow-nets in Loch Achray, *Diaptomus*, *Daphnia*, and *Bosmina* being taken in all the gatherings. *Holopedium*, though common in September and June, was not observed in November and March; *Bythotrephes* also appears to be subject to somewhat similar seasonal variation. Fifty species of Entomostraca and four species of Mollusca were obtained by the hand-net, and by dragging the tow-net for a short distance over the bottom of Loch Achray. Three rare species: *Diaptomus wierzejskii*, *Lathonura rectirostris*, and *Monospilus dispar* were obtained, and in June a green fresh-water sponge (*Spongilla fluviatilis*) appeared to be moderately common in some shallow parts of the loch. †

Loch Vennachar contains a rich crustacean fauna, as well as other invertebrates, most of which are suitable for fish food. Of forty-five species of Crustacea recorded from Lochs Katrine, Achray, and Vennachar, thirty-five species were observed in Loch Vennachar; thirteen of the species from Loch Vennachar were not observed in either Loch Katrine or Achray; fifteen of the species were common to the three lochs ‡

Twenty-five species of Crustacea and four species of Mollusca are recorded from Loch Lubnaig, including a new cladoceran (*Alona neglecta*), and one or two species new to Britain.§

Rainfall and Outflow.

An attempt has been made to arrive at an approximation to the total amount of rain falling annually on the drainage areas of the lochs under consideration, although the available records are far from sufficient for the purpose. Dr. Alexander Buchan, F.R.S., has kindly supplied us

* Scott, *Seventeenth Report of the Fishery Board for Scotland*, pt. iii. pp. 143–146.
† *Ibid.*, pt. iii. pp. 153–156.
‡ Scott, *Fourteenth Report of the Fishery Board for Scotland*, pt. iii. p. 167, 1895.
§ Scott, *Thirteenth Report of the Fishery Board for Scotland*, pt. iii. p. 247, 1894.

with information regarding the readings of the rain-gauges at observing stations within, and in the vicinity of, the catchment-basins of these lochs. The positions of these rainfall stations, and the mean annual rainfall, are shown on one of the maps accompanying this paper (see Map III.), and further particulars will be found in the following table:—

Station.	Height of rain-gauge above sea-level.	Years observed.	Mean annual rainfall in inches.
	Feet.		
Ardlui	50	1865–70	115·10
Firkin	100	1866–79	98·38
Arrochar	15	1864–98	81·31
Head of Duchray	1800	1854–98	84·27
Glengyle	380	1854–98	92·25
Top of hill, Loch Katrine tunnel	830	1861–98	77·95
Brig o' Turk	270	1854–98	64·47
Loch Drunkie	420	1861–98	63·62
Loch Vennachar	275	1861–98	57·31
Between Ben Ledi and Glen Finlas	1800	1854–98	53·68
The Gart	230	1872–98	54·47
Leny	345	1861–98	54·23
Blaircreach	460	1893–98	82·63
Stronvar	422	1860–98	75·49
Lochearnhead	320	1866–84	65·50
Tyndrum	792	1858–61, 72–3, 76–7	90·10

Grouping these stations and their mean annual rainfall into those likely to represent the rainfall on the catchment-basin flowing out of Loch Vennachar, and those representing the rainfall on the catchment-basin flowing out of Loch Lubnaig, we arrive at an average rainfall of 76·25 inches for the Loch Lubnaig catchment, the mean height of the rain-gauges being 538 feet above the level of the sea, and an average rainfall of 75·37 inches for the Loch Vennachar catchment, the mean height of the gauges being 528 feet.

The entire catchment-basin flowing out of Loch Vennachar (*i.e.* the combined drainage-areas of Lochs Katrine, Achray, Drunkie, and Vennachar) is about 75·29 square miles, and the mean height calculated from the bulk of land above the level of the lochs is about 704·185 feet; the mean height of the surfaces of these four lochs above sea-level is 331½ feet, so that the mean height above the sea of the entire catchment is about 1035·685 feet. The entire catchment-basin flowing out of Loch Lubnaig (*i.e.* the combined drainage-areas of Lochs Voil, Doine, and Lubnaig) is about 73·39 square miles, and the mean height above the level of the lochs is about 935·129 feet; the mean height of the surfaces of these lochs above sea-level is 412 feet, so that the mean height above the sea of the entire catchment is about 1347·129 feet.

The usual practice among engineers is to add 2½ per cent. of rainfall for each 100 feet of height above rain-gauges. Applying this rule to

the Loch Vennachar catchment-basin, where we have an observed rainfall of 75·37 inches at an average height of 528 feet, we must add 12·7 per cent. for the additional 508 feet of mean height, making an average annual rainfall over the entire catchment of 84·94 inches. This would give an annual fall of rain on the entire catchment equal to 14,857,214,000 cubic feet. Applying this rule, in like manner, to the Loch Lubnaig catchment-basin, where we have an observed rainfall of 76·25 inches at an average height of 538 feet, we must add 20 per cent. for the additional 809 feet of mean height, making an average annual rainfall over the entire catchment of 91·5 inches. This would give an annual fall of rain on the entire catchment equal to 15,600,760,000 cubic feet.

There is another method of estimating the rainfall, without taking the mean height of the drainage-area into consideration. Supposing the usually accepted increase of $2\frac{1}{2}$ per cent. per 100 feet of height, and also the mean annual rainfall at the average height of the rain-gauges, to be approximately correct, it is possible to calculate the rainfall at any given height. For the Loch Vennachar catchment the probable rainfall at the same heights and intervals as the contour-lines on the Ordnance Survey maps has been calculated from the starting-point of the mean of the observing stations 75·37 inches at 528 feet. Thus at the surface of Loch Vennachar the rainfall would be about 70·5 inches; at 500 feet above the sea, 75·2; at 750 feet, 79·9; at 1000 feet, 84·6 inches; and so on, adding $6\frac{1}{4}$ per cent. for each succeeding interval of 250 feet. Multiplying the area between any two consecutive contour-lines by the mean of the two figures calculated for the same two lines should give an approximation to the amount of rain falling on that area. The result as obtained by this method for the entire catchment-basin flowing out of Loch Vennachar is given in the following table:—

				Cubic feet.
Level of lochs to 500 feet,	16·53 square miles	×	72·8 inches	= 2,795,710,000
500 „ 750 „	10·67 „	×	77·5 „	= 1,921,117,000
750 „ 1000 „	10·35 „	×	82·2 „	= 1,976,514,000
1000 „ 1250 „	9·46 „	×	86·9 „	= 1,909,847,000
1250 „ 1500 „	10·22 „	×	91·6 „	= 2,174,874,000
1500 „ 1750 „	7·86 „	×	96·3 „	= 1,758,476,000
1750 „ 2000 „	5·94 „	×	101·0 „	= 1,393,784,000
2000 „ 2250 „	3·06 „	×	105·7 „	= 751,422,000
2250 „ 2500 „	0·99 „	×	110·4 „	= 253,917,000
over 2500 „	0·21 „	×	115·1 „	= 56,154,000
		Total	... ...	14,991,815,000

This result comes very near to that obtained from the calculation based upon the mean height, which gave a total annual rainfall of 14,857,124,000 cubic feet.

Applying the same method to the entire catchment-basin flowing out of Loch Lubnaig, we arrive at the following result:—

					Cubic feet.
Levels of lochs to	500 feet,	6·82	square miles ×	74·6 inches	= 1,181,982,000
500 „ 750	„	7·15	„ ×	77·9 „	= 1,293,991,000
750 „ 1000	„	9·05	„ ×	82·7 „	= 1,738,769,000
1000 „ 1250	„	9·70	„ ×	87·4 „	= 1,969,568,000
1250 „ 1500	„	9·89	„ ×	92·2 „	= 2,118,434,000
1500 „ 1750	„	9·43	„ ×	97·0 „	= 2,125,060,000
1750 „ 2000	„	8·06	„ ×	101·7 „	= 1,904,337,000
2000 „ 2250	„	6·64	„ ×	106·5 „	= 1,642,879,000
2250 „ 2500	„	3·30	„ ×	111·3 „	= 879,148,000
2500 „ 2750	„	1·88	„ ×	116·1 „	= 507,081,000
2750 „ 3000	„	1·02	„ ×	120·8 „	= 286,256,000
over 3000	„	0·35	„ ×	126·6 „	= 102,941,000
			Total	... ...	15,750,446,000

Here, again, there is a close agreement between the result obtained by this method and that calculated from the mean height, which gave a total annual rainfall of 15,600,760,000 cubic feet.

A third method of estimating the amount of rain falling on any particular region is afforded by drawing lines of equal rainfall, measuring the areas between the lines, and multiplying by the mean annual rainfall. Where the lines are based upon sufficiently numerous records of the rainfall at various heights, this method should give excellent results; but in the cases under discussion the number of observing stations is small, and the majority of the rain-gauges are situated on the low-lying grounds, only two being placed at heights exceeding 1000 feet, both at 1800 feet: therefore the figures obtained in these cases are most probably below the truth. Nevertheless, we have attempted to lay down the lines of equal rainfall from the available records, as shown on the rainfall map accompanying this paper (see Map III.). The areas enclosed by the lines of rainfall have been measured with the planimeter, and the rainfall calculated for the Loch Vennachar catchment-basin, with the following results:—

					Cubic feet.
50 to 60	inches,	12·35	square miles ×	55 inches	= 1,578,040,000
60 „ 70	„	28·97	„ ×	65 „	= 4,374,714,000
70 „ 80	„	18·93	„ ×	75 „	= 3,298,372,000
80 „ 90	„	8·55	„ ×	85 „	= 1,688,400,000
90 „ 100	„	4·21	„ ×	95 „	= 929,166,000
100 „ 110	„	2·28	„ ×	105 „	= 556,175,000
			Total	... ...	12,424,867,000

In like manner, the rainfall has been calculated for the Loch Lubnaig catchment-basin, with the following results:—

					Cubic feet.
50 to 60	inches,	3·79	square miles ×	55 inches	= 484,272,000
60 „ 70	„	23·89	„ ×	65 „	= 3,607,591,000
70 „ 80	„	21·79	„ ×	75 „	= 3,796,700,000
80 „ 90	„	19·02	„ ×	85 „	= 3,755,928,000
90 „ 100	„	4·41	„ ×	95 „	= 973,307,000
100 „ 110	„	0·49	„ ×	105 „	= 119,530,000
			Total	... ...	12,737,328,000

The results obtained by these three methods may be summarized thus:

	Vennachar catchment.	Lubnaig catchment.
First method ...	14,857,214,000	15,600,760,000
Second „ ...	14,991,815,000	15,750,446,000
Third „ ...	12,424,867,000	12,737,328,000
Mean ...	14,091,299,000 c. ft.	14,696,178,000 c. ft.

Since Loch Katrine has been made use of by the Glasgow Corporation as the source of the water-supply to that city, a record has been kept of the amount of water flowing out of Lake Vennachar—or rather, a record has been taken twice a day of the depth of water flowing over a weir at Coilantogle, from which the quantity of water discharged may be calculated. When the height of the water on the weir exceeded 5 inches, the weir became a drowned weir, so that it was difficult to estimate the outflow, as there was a considerable velocity of approach, especially during floods.

Mr. Gale has kindly supplied us with the readings, taken twice a day during the year 1869, of the depth of the outflowing water at Coilantogle, and from these figures the outflow has been estimated for that year at 9,572,000,000 cubic feet. The year 1869 was the driest year during a period of twenty-four years, and we are not satisfied that this computation can be accepted as a very correct estimate of the outflow from this catchment-basin even for that year. It would have been interesting to have calculated the outflow for twenty-five years in the same way as we have done for the year 1869, and to have taken the mean. However, accepting the above estimate for the year 1869, and adding to it the quantity of water supplied to Glasgow for that year, which, from Mr. Gale's table showing the average amount of water supplied per day during the first six months of the years 1866 and 1871, may be taken at about 1,659,300,000 cubic feet, we find that the mean rainfall exceeds the outflow in this year by

According to the first method	3,625,914,000 cubic feet.
„ „ second „	3,760,515,000 „
„ „ third „	1,193,567,000 „
or a mean of	2,859,999,000 „

Leslie* made experiments for twenty consecutive years on the allowance to be made for absorption by vegetation and for loss by evaporation, and he calculated that the average annual amount of water absorbed and evaporated is equal to about 13 inches of rainfall. On this basis, and assuming for the present that the evaporation from the surface of the water is equal to absorption and evaporation from the land, the total amount of water lost through absorption and evaporation over the entire catchment-basin of Loch Vennachar would be about

* See *Jour. Scot. Met. Soc.*, vol. v. p. 108, 1878.

2,273,885,000 cubic feet per annum.* Comparing this figure with the figures given above showing the excess of rainfall over outflow, we observe that, according to the mean of the three methods, the difference between the rainfall and outflow is greater than would be accounted for by absorption and evaporation as estimated by Leslie, there being an excess according to the first two methods, and a deficiency according to the third method.

The foregoing figures, calculated for the year 1869, show that the rainfall unaccounted for by outflow at Coilantogle, and supply of water to Glasgow, is according to the first method 26 per cent., according to the second method 27 per cent., and according to the third method 8 per cent.: this percentage must be referred to loss by absorption, evaporation, and the loss of water through underground channels.

Notes on the Geology of the Loch Katrine District.†

By Messrs. Ben. N. Peach, F.R.S., and John Horne, F.G.S., from unpublished observations made during the course of the Geological Survey of Scotland.

All the lochs referred to in this paper, with the exception of Loch Arklet, lie within the catchment-basin of the river Teith above Callander. Though situated about a mile to the west of Loch Katrine, the small lake, Loch Arklet, drains into Loch Lomond.

1. *Geological Structure of the area embracing these Lochs.*

All the lochs, save the lower part of Loch Vennachar, lie within the territory of the crystalline schists of the Highlands, which are bounded along the Highland border by a powerful fault stretching from Stonehaven to the Firth of Clyde. As shown on the geological sketch-map accompanying this paper, this dislocation extends from Aberfoil north-east by Leny to Luirgeann on the Kelty water. On the south-east side of this fault the strata belong to the lower Old Red Sandstone formation, comprising, next the fault, andesitic lavas and agglomerates well seen in the Kelty water. Further to the south-east there is a broad belt of conglomerate arranged in beds, which are inverted or vertical near the fault, and as the observer approaches the plain they dip towards the south-east and pass underneath the overlying red sandstones.

On the north-west side of this great boundary fault of the Highlands there is a narrow strip of sedimentary rocks about half a mile in breadth, referred provisionally to the Arenig division of the Silurian

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* The evaporation from the surface of the lakes will, of course, exceed Leslie's figures for loss through absorption and evaporation.

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system, and consisting of red and black shales, radiolarian cherts, limestones and grits.

To the north of this belt of doubtful strata, the whole of the area included in the geological map accompanying this paper is occupied by rocks grouped under the general term of the crystalline schists of the Highlands. The latter are arranged in a definite order, but as yet it is uncertain whether it indicates the original sequence of deposition. The groups are here given in apparent descending order—

7. Garnetiferous mica-schists.
6. Loch Tay limestone with sills of epidiorite.
5. Mica-schists with sills of epidiorite.
4. Schistose epidotic grits ("Green Beds").
3. Ben Ledi grits, massive and sometimes schistose.
2. Aberfoil slates with subordinate bands of grit.
1. Leny and Aberfoil grit.

For a distance of about 5 miles northwards from the great boundary fault, the members of groups 1 to 4 are arranged in more or less parallel belts or strips running south-west and north-east, the strata dipping at high angles to the north-west. The groups appear in consecutive order, the Leny and Aberfoil grit being exposed immediately to the north of the doubtful Arenig rocks, while the Aberfoil slates and Ben Ledi grits appear successively to the north. The schistose epidotic grits (group 4), which lie apparently at the top of the Ben Ledi grits, are developed still further to the north, being traceable from a point not far to the south of Ben Lomond, north-east by Loch Chon and the lower part of Loch Katrine, thence across the hills to Strathyre and Loch Voil. From the Braes of Balquhidder they can be followed northwards to Glen Dochart, and they reappear in Glen Falloch in the extreme north-west part of the map. At the head of Loch Lubnaig and in the Braes of Balquhidder sills or intrusive sheets of epidiorite occur at no great distance from the "Green Beds."

In the belt between Loch Chon and Loch Lubnaig the "Green Beds," together with the Ben Ledi grits, form a series of compound synclinal folds, the strata being inclined at high angles. To the north and west of the "Green Beds" the representatives of the Ben Ledi grits reappear and cover a wide area, extending from Ben Lomond north-east by Loch Katrine and the heights surrounding the head of Loch Voil, northwards by Ben More and westwards to Glen Falloch. Throughout this extensive area the strata are inclined at gentle angles: in marked contrast with the structure along the Highland border already indicated. There is here a change, over part of the area at least, in the lithological characters of the Ben Ledi grit group. The strata become more schistose and micaceous, merging in places into mica-schists. The accompanying geological map shows generally where these grits still retain their massive character and where they merge into mica-schists.

The outcrop of the Loch Tay limestone is indicated on the geological map, from which it will be seen that this limestone, together with the sills of epidiorite, is traceable from the upper part of Strathyre, by the Kirkton glen, to Luib, in Glen Dochart.

In addition to the great boundary fault already referred to, separating the lower Old Red Sandstone from the crystalline schists, various faults trending N.N.E. and S.S.W. traverse the south-east part of the area under consideration. These are, in the main, branches of the great dislocation which has been traced across the Highlands for a distance of 60 miles, from Loch Vennachar by Loch Lubnaig and Loch Tay to Glen Tilt. In common with the dislocation referred to, the branch faults have a down-throw to the west or north-west, and they shift for some distance the outcrops of the strata which they traverse. They are truncated by the great boundary fault of the Highlands, and may be of pre-Old-Red-Sandstone age.

The existing valley-system of the basin of the Teith has been carved out of a tableland of crystalline schists of varying hardness. Though there is conclusive evidence of great erosion during the successive glaciations of the region, yet it is clear that the present valley-system must have been developed in pre-glacial time. There is one point connected with the geological structure of this region which has had an important bearing on the evolution of the valley-system. Along the Highland border, as already indicated, there is a great development of conglomerates, coarse pebbly grits, and greywackes, belonging partly to the crystalline schists and partly to the Old Red Sandstone. These strata, being vertical or nearly so, would be much less easily eroded than the gently inclined schistose rocks lying to the north-west. Such an arrangement would naturally lead to the formation of narrow and comparatively flat-bottomed valleys behind rocky gorges, the latter being cut through the vertical beds of hard grit and conglomerate along the Highland border. That this remarkable structure must have likewise contributed to the erosion of rock-basins during the glacial period will become apparent on a closer examination of the geological structure of the area traversed by the larger lakes.

In the case of Loch Katrine, which is the largest and deepest of the lochs under consideration, there is a great rocky barrier at its outlet due to the Ben Ledi grits. Here they form a belt over a mile in breadth, and give rise to the rugged scenery so characteristic of that region. They appear on the crags of the Trossachs at the mouth of the loch, on the crest and slopes of Ben Venue (2393 feet), on Ben Bhreac (2295 feet), and on the heights round Ben An (1326 feet). The strike of these hard and durable strata is E.N.E. and W.S.W.—that is, at right angles to the outlet of the loch, and the beds are vertical or highly inclined.

The potency of the Ben Ledi grits as a rocky barrier must have been considerably increased by the development of epidotic grits or "Green

Beds" lying immediately to the north. The latter, though not so massive as the Ben Ledi grits, are hard and durable; they are repeated by a series of compound folds for nearly a mile across the strike, their northern limit being near Brenachoil Lodge. Their trend is likewise north-east and south-west, and the beds are vertical or highly inclined.

On both sides of Loch Katrine above Brenachoil Lodge the geological structure is widely different, for in this area the Ben Ledi grits, greywackes, and slates reappear in a highly schistose form, the strata dipping generally at low angles to the south-east. Over much of this region, as already indicated, the altered sediments merge into mica-schists owing to the development of mica. It is obvious that these materials would yield more readily to the agents of denudation than the massive pebbly grits of Ben Venue and the Trossachs.

Loch Achray, which lies about a mile to the east of the outlet of Loch Katrine, is only about 88 feet below the level of the latter loch. A powerful fault or dislocation, trending north-east and south-west, crosses the head of the loch near the Trossachs Hotel, which brings the massive Ben Ledi grits to the west in contact with slates to the east. It is a true rock basin which has been excavated mainly in the group of less durable slates.

Loch Vennachar is crossed by the great boundary fault, already referred to, along the Highland border, the floor of the eastern portion being composed of Old Red Sandstone conglomerate, while that of the western part is formed of grits and slates belonging to the crystalline schists. Though there is a covering of drift on both sides of the lower part of the loch, still this sheet of water forms a true rock basin, for the Old Red conglomerate is exposed in the river about 1200 yards below the outlet.

Loch Drunkie presents several interesting geological features. On referring to the map it will be seen that an arm of this loch runs nearly east and west for upwards of half a mile; the northern margin is composed of massive grits, while the southern margin and probably the floor of this branch of the loch is formed of less durable slates. Another arm of this lake runs N.N.E., in the direction of Loch Vennachar, the eastern margin of which nearly coincides with the course of a fault that crosses Loch Vennachar to the east of Lanrick.

The three lakes, Loch Doine, Loch Voil, and Loch Lubnaig, must have formed one continuous sheet of water in post-glacial time. Loch Doine is now separated from Loch Voil by two cones of alluvium, to be referred to presently. Loch Voil is separated from Loch Lubnaig by a narrow plain of alluvium 5 miles in length, the surface of Loch Lubnaig being 9 feet lower than that of Loch Voil. These lochs form isolated parts of a true rock basin. Below the outlet of Loch Lubnaig there is a prominent rocky barrier composed of the massive grit of Leny and Aberfoil, from a half to three-quarters of a mile in breadth. The strike

of this pebbly grit is north-east and south-west, and the beds are inclined to the north-west at high angles.

Loch Lubnaig is traversed by several faults, to which special reference will be made in the sequel. The lower part of the loch coincides with the trend of two faults, which, in all likelihood, determined for some distance the course of the river in remote geological time.

2. *Glaciation.*

The glacial phenomena in the lake district of the basin of the Teith prove beyond doubt that, during the climax of the ice-age, the ice-shed lay to the north of the area now under consideration; that the ice-movement was more or less independent of the existing valley-system; and that even the highest mountains were overridden by the ice. This great development was followed by a period of local glaciation, when the glaciers were confined mainly to the existing valleys, and when the boulder-clay or ground-moraine of the earlier period was largely removed. The upper limit of the valley glaciation is frequently defined by prominent lines of moraines strewn with boulders, which rise to a considerable height on the mountain-slopes. The evidence pointing to these conclusions may now be briefly summarized.

On the watershed to the north of Lochs Doine and Voil, the trend of the ice-movement during the great glaciation, as proved by the striæ, was S.S.E. Again, on the lofty watershed east of Loch Lubnaig and south of Loch Earn, between Ben Each (2660 feet) and Ben Vorlich (3224 feet), there is conclusive evidence that the highest mountains in that part of the lake district were overridden by the ice. There the mountains are composed of grits, and the striæ are well preserved. On Ben Each the striæ point S.E.; on the col between that hill and Stuc a Chroin, S. 40° E.; on the latter mountain about S.E., and on the slopes of Ben Vorlich, at a height of 2500 feet, the trend of the ice-markings is E. 40° S. In the tract between Loch Lubnaig and Loch Katrine similar evidence is obtained of a south-easterly movement at great elevations. For example, on Ben Vane (2685 feet), at a height of 2642 feet, the striæ point S. 15° to 20° E.; on the north and west slopes of Ben Ledi, S. 35° E., and on the crest of that mountain, at a height of 2875 feet, the direction is S.E. In like manner the mountains guarding the outlet of Loch Katrine are glaciated to the summit. Striæ occur on the top of Ben Venue at a height of 2386 feet, pointing S. 40° E.; on Ben An, at an elevation of 1750 feet, E. 30° S.; and on Ben Bhreac, to the west of Ben Venue, the direction of the ice-markings is S. 30° to 40° E. Again, on the watershed between Loch Voil and Loch Katrine, the evidence indicates a south-easterly movement during the great extension of the ice. For instance, at various points on Taobh na Coille, at elevations between 2000 feet and 2250 feet, the striæ point S. 30° E., and on Meall Gaothach, S. 30° E. In the tract immediately to the south-west

Loch Katrine the trend of the ice-markings varies from S.S.E. to E.S.E. For example, on Maol Mor (2249 feet) about the 2000-feet contour-line, to the north of Loch Arklet, the direction is about S. 15° E.; and on the crest of Ben Uaimhe, to the south of that loch, S. 10° to 15° E. Eastwards, throughout the tract between Loch Chon and the Trossachs, the trend is E.S.E. To the south of the lofty heights stretching from Ben Venue towards Ben Ledi, the direction of the striæ is more easterly, thus showing that the ice, after crossing the high ground, was deflected more towards the east (see glacial striæ on Map II.).

The general south-easterly movement of the ice during the great glaciation, throughout the lake district of the basin of the Teith, is confirmed by the dispersal of stones in the boulder-clay, and by the transport of erratics. Many of the boulders have been carried far from their source, and are now found on the tops of the highest mountains of the district, some even at greater elevations than the parent rock.

To the east of Loch Lubnaig, on Ben Vorlich, at a height of 3000 feet, boulders of garnetiferous mica-schist are found resting on glaciated surfaces of pebbly grit. Again, on the same mountain, at a similar elevation, there are erratics of epidiorite and hornblende-schist—rocks which are associated with the Loch Tay limestone, and which must have been transported from lower ground to the north. Similar boulders are met with on Stuc a Chroin and on Ben Each. Again, in the boulder-clay on the slopes of Ben Ledi, blocks of hornblende-schist occur, which must have been transported for some distance. On the south side of Loch Katrine, between Stronachlachar and the aqueduct of the Glasgow waterworks, boulders of quartzite and garnetiferous mica-schist, which are foreign to the basin of Loch Katrine, are found in the boulder-clay. Eastwards near Brenachoil Lodge, on the north side of Loch Katrine, there are blocks of black schist, like that which accompanies the quartzite of central Perthshire, and which has not been detected within the catchment-basin of Loch Katrine. These examples are sufficient to prove that, during the climax of the glacial period, the ice-movement was independent of the existing valley-system. Indeed, from the evidence furnished by the striæ and the transport of boulders, it may be inferred that the minimum thickness of the ice-sheet during this period must have been not less than 3000 feet in the lake district of Perthshire.

The boulder-clay or ground-moraine, which was laid down during the great glaciation, must have been extensive, for it is found at great elevations, and it sometimes attains a great thickness. For instance, in the lee of the ridge of Ben Vane, to the west of Loch Lubnaig, it reaches a height of 2290 feet, and in places it is over 100 feet thick. But a large part of this deposit was removed during the later glaciation by the valley glaciers, for the relics occur above the limits of the valley-moraines, the latter resting frequently on the solid rock.

Only a brief allusion is necessary to show the development of the later glaciers. The striæ produced by this later movement coincide generally with the trend of the existing valleys. But though this is true, there is evidence to prove that even the larger valley-glaciers were thick enough to overflow minor watersheds. For instance, the glacier which descended the basin of Loch Katrine was thick enough to override the low col between that loch and Loch Chon, while another branch passed westwards by Loch Arklet towards Loch Lomond. Another example of the same phenomenon might be quoted. The glacier which descended the basin of Loch Voil towards Loch Lubnaig was thick enough to overflow the col between Strathyre and Loch Earn, while another branch ascended Glen Buckie and joined the Loch Lubnaig glacier at Laggan.

Moraines are well developed in most of the valleys, and are frequently arranged in concentric lines, as in Glen Finglas, north of Brig o' Turk. On the south side of Loch Katrine, between the jetty and Glasahoile, the moraines are distributed in parallel lines along the shore of the lake. As already indicated, the upper margins of the valley-glaciers are defined by the moraines.

3. *The Soundings viewed in Relation to the Geological History of the Area, and with Reference to the Origin of the Lakes.*

Loch Doine, Loch Voil, and Loch Lubnaig.—Reference has already been made to the fact that, in post-glacial time, Loch Doine, Loch Voil, and Loch Lubnaig must have formed one continuous sheet of water, and that their subsequent isolation has been due to the deposition of sediment.

Loch Doine has been separated from Loch Voil by alluvial cones laid down by two streams, one from the north at Monachylemore, and another from the south at Monachyle Tuarach. The 50-feet subaqueous line has been traced round the Loch Doine basin, and the deepest sounding is 65 feet. At the head of this loch there is an alluvial flat that stretches westwards for $1\frac{1}{2}$ miles, formed by the Lochlarig river and its tributaries. The gradual silting up, which is in constant progress at the head of Loch Doine at the mouths of the Lochlarig river and Allt Carnaig, is well shown by the resultant curve in the 50-feet contour-line.

That Loch Voil is merely a continuation of the Loch Doine basin is further proved by the soundings, for immediately to the east of the cones just referred to, the 50-feet contour-line is met with, and has been traced round both sides of the loch eastwards to about Ledereich—a distance of about 2 miles. From this point eastwards the lake gradually shallows towards the alluvial flat at Balquhidder, where moraines occur within 400 yards of Kirkton and Stronvar Bridge. The deepest part of the lake is enclosed by the 90-feet contour-line at the head of the loch near Monachylebeg, and the deepest sounding within this line is 98 feet.

The trend of Lochs Doine and Voil roughly coincides with the strike of the crystalline schists in that district. It is oblique—indeed, nearly at right angles—to the movement of the great ice-sheet during the climax of glacial conditions, and it harmonizes with the course of the later valley-glacier. Several small faults occur on the Braes of Balquhidder, north of Loch Voil, and on the hill-slope south of Loch Doine, but these are of little structural importance.

The long stretch of alluvium that separates Loch Voil from Loch Lubnaig has been laid down by the Calair burn in Glen Buckie, by the Kirkton burn at Balquhidder, and by various streams on both sides of Strathyre. The silting up now in progress at the head of Loch Lubnaig is well shown by the tongues of alluvium, on both sides of the Balvag river, that project for some distance into the loch and isolate small basins of fresh water. About half a mile north of Loch Lubnaig a moraine rises out of the alluvium, probably a fragment of the adjacent moraine on both sides of the valley. As the top of this moraine probably rose above the level of the ancient united lake, the depth of the latter near this locality could not have been very great.

A glance at the chart of Loch Lubnaig will show that its floor is much more irregular than that of Loch Voil. This may be accounted for partly by the presence of alluvial cones formed by various streams, and by features connected with the geological structure of the basin.

The deepest parts of this lake form two basins enclosed by the 100-feet contour-line, one to the north and the other to the south of Ardchullarie More. The upper one, about 500 yards long, is 146 feet deep, and the lower one, about 900 yards long, is 108 feet in depth. Though now separated by alluvial detritus brought down by the Ardchullarie burn from the north-east, and by the Dubh Shruith burn from the south-west, these basins were probably originally continuous. The powerful Loch Tay fault with a N.N.E. and S.S.W. course, and with a downthrow to the west, crosses Loch Lubnaig immediately to the south of Ardchullarie More, and strikes the west margin of the lake near the spit of sand to be referred to presently (see Map II.). The steep gradient on the west side of the lake to the north and south of this spit of sand coincides with the course of the Loch Tay fault. About a quarter of a mile to the west of the Loch Tay fault a minor dislocation, with a similar trend and downthrow, crosses the lake and follows the channel of the Dubh Shruith burn. Now the lower deep basin lies to the east or upthrow side of the Loch Tay fault, and the upper deep basin is on the west or downthrow side of the Dubh Shruith fault. These dislocations doubtless produced brecciation of the strata along the lines of movement, which led to more rapid disintegration of the materials.

Close to the north-west limit of the upper basin enclosed by the 100-feet contour-line the loch shallows to 20 feet, and from thence north-westwards to a point opposite Bienacreag the depth increases to

62 feet. Here there is a small basin enclosed by the 50-feet contour-line.

At the lower end of the loch, on the east side, there is a steep gradient which coincides with a line of fault, having a downthrow to the west (see Map II.). As already indicated, this dislocation together with the Loch Tay fault may have determined in part the course of the river in remote geological time. But an impartial consideration of the evidence furnished by the soundings shows that the faults cannot account for the erosion of the lake basin. The striking fact that the lower deep basin of Loch Lubnaig coincides with the upthrow side of the Loch Tay fault—the most powerful dislocation traversing the crystalline schists of this area—shows that this rock-basin must be ascribed to an erosive agent acting independently of the lines of fault. It has further been shown that Lochs Voil and Doine must have been originally continuous with Loch Lubnaig. The deepest sounding in Loch Voil is 98 feet, and in Loch Lubnaig 146 feet, and it is obvious that their erosion must be ascribed to a common cause. The upper part of Loch Lubnaig coincides roughly with the trend of the ice-sheet during the great glaciation, which, from the evidence adduced in the foregoing pages, must have attained a minimum thickness of 3000 feet. But the basin must have undergone further erosion by the large valley-glacier.

About half a mile to the south of Ardchullarie More, on the west margin of Loch Lubnaig, there is a prominent spit of sand extending into the lake for about 100 yards. It occurs not far to the south of the bend in the lake, at the meeting-point of the waves produced by the prevalent westerly winds. By the action of the waves the sand is steadily borne outwards on both sides of the spit, and from the soundings it is clear that this feature projects far into the lake. Further, it must have been in process of formation when the loch stood at a higher level, for a section appears in the adjacent railway cutting, which shows the sloping layers of sand coinciding with the form of the spit.

Loch Lubnaig originally extended to a point below Coireachrombie, about three-quarters of a mile below its present outlet. This point has been silted up by the detritus laid down by the Stank and Anie burns. The original southern termination of the lake touched the rocky barrier formed by the Leny grit. It is worthy of note, also, that the level of Loch Lubnaig has been lowered about 20 feet by the denuding action of the river Leny.

Loch Katrine.—For a distance of 4 miles west from Brenachoil Lodge to Stronachlachar—about the half of the total length of the loch—this lake has a comparatively flat bottom, enclosed by the 400-feet contour-line. The deepest sounding in Loch Katrine, 495 feet, is at the eastern limit of this basin, nearly due south of Brenachoil. The chart shows that the soundings throughout this basin gradually increase in depth eastwards to Brenachoil Lodge. The position of the deepest sounding

is of interest, seeing that the strata which form the floor of the lake at this point consist of schistose micaceous grits, to the north-west of the epidotic grits ("Green Beds") and the Ben Ledi grits, the two latter groups having formed the great rocky barrier at and above the outlet of the lake.

Near the upper end of the loch a rocky barrier crosses the lake from Portuellan by the Black island to Rudha Maoil Mhir an-t Salainn. The deepest sounding along this barrier is 90 feet, and the shallowest is 48 feet. On its lower side the 100-feet contour-line well-nigh crosses the lake. Above it there is another basin over half a mile in length, the greatest depth of which is 128 feet, immediately in front of the rocky ridge just referred to. Westwards the lake shallows, and at its head it has been silted up for a distance of half a mile by the alluvium laid down by the Gyle river.

Below Brenachoil Lodge the soundings show an uneven floor, due probably to ridges of rock rather than to morainic deposits, if we may judge from the geological features on both sides of the lake. Ellen's isle is composed of epidotic grits ("Green Beds"), and the promontories of Am Priosan partly of "Green Beds" and partly of Ben Ledi grits. The promontory between the pier and the sluice is formed of Ben Ledi grits.

During the geological survey of that region several small faults were found to cross Loch Katrine, but these are of minor importance, and have produced locally a slight brecciation of the strata. It is a typical example of a rock basin. The deepest sounding occurs in the front of the great rocky barrier in the lower part of the lake, in accordance with what we might naturally expect on the theory of glacial erosion. Though the soundings prove the deepest part of the lake to be 131 feet below sea-level, yet this depth is in proportion to the vast thickness of the ice during the successive glaciations of the basin.

Loch Achray.—This lake forms one basin, the deepest part being enclosed by the 90-feet contour-line, and the deepest sounding being 97 feet. A fault, with a downthrow to the west, crosses the head of the loch at the Trossachs Hotel, which has produced considerable brecciation of the strata, a feature probably continued along the floor of the loch between the hotel and Achray. The greater part of this lake is on the upthrow side of the fault just referred to, and the basin, as already indicated, has been excavated mainly in slates.

Loch Vennachar.—Between Loch Achray and Loch Vennachar there is a strip of alluvium, the difference in level between the two lakes being 6 feet. The successive terraces show that these two lakes originally formed one sheet of water, which stood at a somewhat higher level. Loch Vennachar contains one prominent basin, about 2 miles in length, enclosed by the 50-feet contour-line. Within this limit there are two smaller basins, which fall below the level of the

100-feet contour-line (see Map V.). The deepest sounding is 111 feet, which occurs to the north-east of Invertrossachs, on the line of the great boundary fault along the Highland border, which has a downthrow to the south-east. West of this dislocation the floor of the lake rises sharply to a level of 20 feet below the surface. Westwards, however, near Lanrick, the depth increases to 50 feet, a feature which coincides with the course of two faults crossing the loch—branches of the Loch Tay fault, and each having a similar downthrow to the west. Doubtless where the deep soundings coincide with lines of fault, the strata have been much shattered and crushed, which has led to the more rapid disintegration of the materials. But though these faults may have led to local modifications of the floor of the lake, they obviously do not account for the excavation of the basin. The long, narrow hollow, crossing obliquely these lines of dislocation, points to glacial erosion.

Loch Drunkie.—Reference has already been made to the geological features of this basin (see p. 345). In the western portion of the west branch, where the hollow has been scooped out of slates, a small part of the floor is enclosed within the 50-feet contour-line. The deepest sounding, 97 feet, occurs in the north branch of the lake in front of a ridge to the east, which rises to a height of about 150 feet above the loch. The direction of the striæ at Loch Drunkie is E. 20° S., and the deepest sounding is found where the erosion must have been greatest.

Loch Arklet.—This lake lies across the path of the great ice-sheet, and coincides with the trend of the later movement (see pp. 347 and 348). Both the north and south shores of this loch are surrounded by moraines, but though such is the case, the stream flows over solid rock, where it leaves the alluvial flat $1\frac{1}{2}$ miles west of the outlet, and continues to flow for half a mile over solid rock. Originally the lake must have extended westwards to this barrier, for the intervening strip of alluvium has been laid down by the burns joining the Arklet water not far from the outlet. On this flat there are moraines rising up in the midst of the alluvium. The greatest depth of the loch is 67 feet. At the upper or east end, where the loch is shallow, two islets appear, one formed of solid rock and the other of moraine matter.

The soundings of the various lakes in the basin of the Teith above Callander, when viewed in connection with the geological structure and glacial phenomena of that area, furnish strong evidence in support of the theory of their excavation by ice-action. It is probable that, though the lakes lie, as a rule, across the path of the great *mer de glace*, they may have been partially eroded by that ice-sheet; at the same time there can be little doubt that their final modification must have been produced by the large valley-glaciers.

A FRAGMENT OF THE GEOGRAPHY OF ENGLAND.

SOUTH-WEST SUSSEX.*

By HUGH ROBERT MILL, D.Sc., LL.D., F.R.S.E.

Woodlands and Agriculture.—No data have been found to show that there is anything distinctive in the flora or fauna of the district under consideration which would single it out from the neighbouring parts of the south of England. White of Selbourne believed that the wheatear, a bird much sought after as a delicacy and extraordinarily abundant in eastern Sussex, was never taken west of the Arun; but this has been shown to be a mistake. The quality of the fish of the district was formerly renowned. Izaac Walton said there were four good things in Sussex—"a Selsey cockle, a Chichester lobster, an Arundel mullet, and an Amberley trout," all four coming from within the limits of these sheets. There are extensive parks containing a large number of deer. In his 'Deer Parks and Paddocks of England,' published in 1892, Mr. Whitaker enumerates the following which occur in the district under consideration: Arundel Park, 1150 acres, with 600 fallow deer and 30 red deer; Cowdray Park, with 800 acres and 350 fallow deer; Petworth Park, 675 acres and 550 deer; Parham Park, 450 acres and 250 deer; and Burton Park, with 300 acres and from 150 to 180 deer. Probably no equal area in England contains so great a number of deer.

The Agricultural Returns published by the Board of Agriculture deal with whole counties only, and the Board is pledged not to publish the statistics of any individual parish. By grouping the parishes, however, it is possible so to arrange the statistics as to distinguish the main natural divisions of soil from one another in a general way. This cannot be done completely, because one parish frequently extends over several different geological formations, and round the borders of the sheet there are portions of many parishes which have to be left out of account. The central group of parishes includes those lying wholly on the Chalk, and only invaded at one or two points by small tongues of drift in the valleys. This group is flanked to the north by a belt of parishes, each including a narrow strip of Chalk, a narrow strip of Upper Greensand, a narrow strip of Gault, and usually some of the Lower Greensands, but beyond them is a group lying wholly on the Lower Greensands. Similarly, to the south of the Chalk there is a transition belt of parishes partly on Chalk and partly on the drift-covered Tertiary strata; whilst south of these the largest division of all lies wholly on the Tertiaries and drift. Altogether 251 square miles are included in the areas grouped for agricultural statistics out of the 270 square miles of land in the sheets. The totals are given in Table V.; but for purposes of

* Read at the Royal Geographical Society, February 5, 1900. Continued from p. 227.

comparison the ratios in Table VI. will be more useful. Only the chief crops and the principal kinds of live stock are considered, while, for the sake of comparison, the population in the several groups is added.

In the region as a whole there is rather less permanent pasture than

FIG. 11.—THE SOUTH DOWNS FROM CHANTRY FARM, NEAR STORRINGTON.
(*Photograph by Mr. J. Vincent Elsden.*)

arable land, although the grasses grown in rotation with other crops increase the total pasturage to rather more than the area of land under grain and root crops. In 1898 nearly one quarter of the arable land was under wheat, one fifth under oats, and only one-fourteenth under barley.

TABLE V.—AGRICULTURAL STATISTICS. CLASSIFIED TOTALS. 1898.

Group of Parishes.	Area of group.		Arable land.	Pasture.				Woods and plantations.	Grain crops.			Potatoes.	Yield per acre.				Live stock.			Population.
	Acres.	Square miles.	Acres.	Permanent grass. Acres.	Mountain and heath pasture. Acres.	Clover, etc., as rotation. Acres.	Total pasturage. Acres.	Acres.	Wheat. Acres.	Barley. Acres.	Oats. Acres.	Acres.	Wheat. Bushels.	Barley. Bushels.	Oats. Bushels.	Potatoes. Tons	Cattle.	Sheep.	Swine.	
I. Wholly on the *Chalk*	35,732	55·8	10,634	10,194	2,937	2,918	16,049	7,624	2,083	650	2,066	25	36·2	34·1	56·8	3·79	1,904	23,905	609	6,551
II. Partly on and *partly south* of the Chalk	12,975	20·3	6,857	4,901	382	1,673	6,956	1,218	1,639	352	1,220	7	39·8	38·5	64·0	4·25	1,375	17,553	717	2,603
III. Wholly *south* of the Chalk	56,444	88·2	33,099	16,339	50	7,024	23,413	1,522	8,188	2423	6,837	157	41·4	40·0	65·0	6·55	7,906	36,432	5745	34,446
IV. Partly on and *partly north* of the Chalk	33,477	52·4	9,062	13,035	2,965	1,697	17,697	4,738	1,795	778	1,590	74	35·3	32·3	53·7	3·41	3,478	14,159	1336	5,765
V. Wholly *north* of the Chalk	21,910	34·1	7,827	7,045	178	1,601	8,824	1,843	1,598	724	1,267	52	35·0	35·0	54·0	3·60	2,846	6,213	1530	6,184
Whole area ...	160,538	250·8	67,479	51,514	6,212	14,913	72,939	16,945	15,303	4927	12,980	315	39·1	37·2	61·0	5·06	17,509	98,262	9937	55,549

TABLE VI.—AGRICULTURAL STATISTICS. CALCULATED RATIOS. 1898.

Group of Parishes.	Per 100 acres of arable land.						Per 100 acres of wheat.					Per cent. of total area.	Per 100 acres of total pasture.		Per 100 head of cattle.		Per square mile.	Water area. Acres.
	Permanent pasture, including mountain and heath.	Clover and rotation grass.	Woodland.	Wheat.	Barley.	Oats.	Permanent pasture.	Clover, etc.	Barley.	Oats.	Potatoes.	Woodland.	Cattle.	Sheep.	Sheep.	Swine.	Population.	
I. Wholly on the *Chalk*	124·0	27·4	71·7	19·6	6·1	19·4	630	140	31	99	1·2	21·3	11·9	148·9	1255	32	117	27·7
II. Partly on and *partly south* of the Chalk	77·3	24·4	17·8	23·9	5·1	17·8	322	102	21	74	0·4	9·4	19·7	252·3	1279	52	128	17·1
III. Wholly *south* of the Chalk	49·5	21·2	4·6	24·7	7·3	20·6	200	86	29	83	1·9	2·7	33·8	155·6	467	74	391	144·5
IV. Partly on and *partly north* of the Chalk	176·5	18·7	52·3	19·8	8·5	17·5	891	94	43	88	4·1	14·1	19·6	80·0	407	38	110	118·9
V. Wholly *north* of the Chalk	96·1	20·4	23·5	20·4	9·6	16·2	452	100	45	80	3·3	8·4	32·3	70·4	218	54	181	105·4
Whole area ...	86·0	22·1	25·1	22·6	7·3	19·2	380	98	32	85	2·1	10·5	24·0	134·7	561	56	221	413·6

The acreage under rotation grasses and clover was almost the same as that under wheat.

The three chief classes of live stock were kept on the average in the proportion of one pig, two cattle, and ten sheep. By comparing the different groups, an interesting relation will be observed between the geological character of the land and the nature of its productions.

The rich soils of the drift and Tertiaries south of the Chalk are by far the most fertile and the most farmed. They yielded in 1898 over 40 bushels of wheat or barley per acre, 65 bushels of oats, and 6½ tons of potatoes, while every hundred acres of pasturage fed 34 cattle and 156 sheep. The country entirely underlain by the Lower Greensand in the north yielded only 35 bushels of wheat or barley per acre, 54 bushels of oats, and 3½ tons of potatoes, and every hundred acres of its pasturage supported 32 cattle and 70 sheep. This is, in fact, the part of the district where there are fewest sheep, although the number of cattle is little less than in the south. On the Chalk the yield of crops is about the same as on the Greensands, but oats yielded nearly 57 bushels per acre, and were cultivated to the same extent as wheat. The pasture, which was, relatively to area, twice as extensive as in the southern division, fed on every hundred acres only 12 cattle, but 149 sheep.

Summarizing the results, it may be said that in every particular the farms of the southern district were best, the largest proportion of arable land, the smallest proportion of woodland, the heaviest crops, and the largest number of every kind of live stock to the acre of pasturage. On the Greensands north of the Chalk the ground was almost equally divided between arable and pasture land, agriculture was poorer, the extent of unenclosed commons much greater, and the proportional area of land under barley and potatoes greater, though the yield was poorer. On the Chalk the pasture land far exceeded the arable land in amount; the number of sheep kept in proportion to cattle was three times as great as on the coastal plain, and four times as great as on the Greensands to the north; while the proportional area under wheat, barley, and potatoes was the smallest, and that under oats the largest.

Generalizing more broadly still, the coastal plain in the south may be said to be mainly agricultural and grazing country, the Chalk Downs almost wholly pastoral, and the Greensand valley in the north mainly devoted to grazing. The cause of these differences is to be found in the soil, both as regards its composition and its behaviour towards the rain-water which falls on it.

The areas of woodland were calculated in two ways. By direct measurement the woods marked on the map (1895 edition) cover 38·0 square miles, while from the Agricultural Returns for 1898 they amount only to 26·5 square miles. The latter figure only accounts for 251 square miles of the land, the former for 270. Deducting 2·6 square miles which lie, according to measurement, on the 19 square miles left

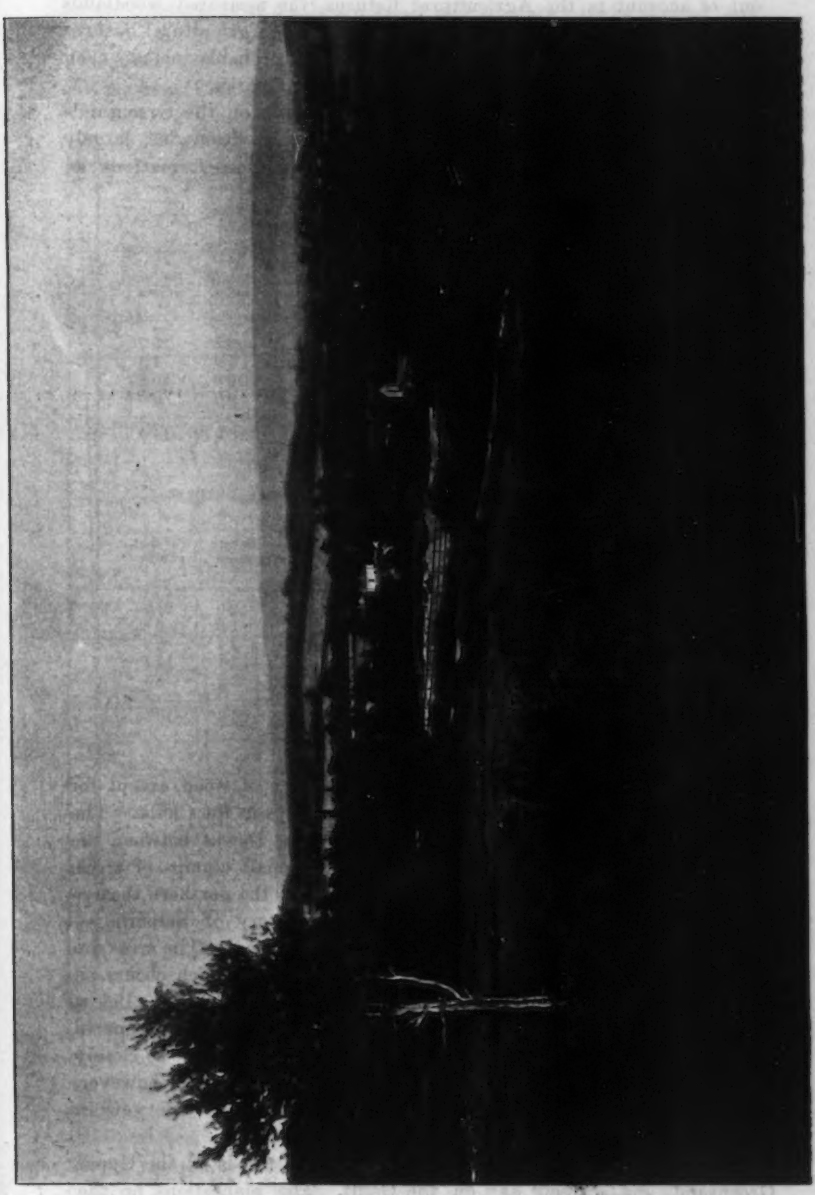


FIG. 12.—THE ROTHER VALLEY AND SOUTH DOWNS, FROM MIDHURST.
(*Photograph by F. Frith & Co., Reigate.*)

out of account in the Agricultural Returns, the measured woodlands cover 35·4 square miles on the area included in the Agricultural Returns —a fair agreement, as the Agricultural Returns probably include open woodlands as pastures, and do not take account of parks.

Pine woods cover only about one square mile on the Greensands north of the Chalk. All the rest of the wood is deciduous, largely beech, and is distributed on the various geological formations as follows:—

TABLE VII.—WOODLANDS IN 1895 FROM MAP.

270 square miles considered.	Square miles.	Per cent. of area
On the Chalk	23·5	29·7
On the Tertiaries and drift	3·9	4·3
On the Lower Greensands	10·6	20·8
On Alluvium	0·0	0·0
Total	38·0	14·0

TABLE VIII.—WOODLANDS IN 1898. AGRICULTURAL RETURNS.

251 square miles considered.	Square miles.	Per cent. of area.
In parishes wholly on Chalk	12·0	21·3
„ partly on and partly south of Chalk ...	1·9	9·4
„ on Tertiaries south of Chalk	2·4	2·7
„ partly on and partly north of Chalk ...	7·4	14·1
„ on Lower Greensands north of Chalk ...	2·9	8·4
Total	26·6	10·5

The summit line of the Downs is usually bare of wood, except for wind-swept bushes, and so are most of the valleys in the Chalk. The rounded summits which rise in the centre of the Downs between the dry valleys are characteristically crowned with small clumps of trees. A broken line of plantation runs along the face of the northern escarpment — the "Hanger" of White's 'Natural History of Selborne'— but the real forest is found on the long southern slopes. The trees are nowhere large, but often very close. The little wood which occurs on the Tertiaries is close up to the northern border near the Chalk. Below the altitude of 50 feet above the sea it is rare to see a tree except in the hedgerows and about the houses; few parts of England are so closely cultivated as the coastal plain of West Sussex. There are, however, some remarkable vestiges of old woods, including a venerable yew in South Bersted churchyard said to be 800 years old.

North of the Chalk escarpment there are no woods on the Upper Greensand, and scarcely any on the Gault. The plantations on the

Lower Greensands as a rule are small and scattered; oaks abound, and the trees are fine.

Parishes.—The combined sheets 317 and 332 include 83 *complete civil parishes* (Chichester being united into one), and portions of 26 other

FIG. 13.—INDEX MAP OF SHEETS 317 AND 332, SHOWING SHEETS OF 6-INCH AND 25-INCH MAPS AND THE BOUNDARIES OF PARISHES.

parishes (Fig. 13). These correspond closely with the ancient or ecclesiastical parishes, but it would appear that the parishes used as units for the Census returns are not quite coterminous with those on which the Agricultural returns are based. It would take too much space to go into

the difficult question of changes of parish boundaries, and in what follows the parishes referred to are those laid down on the 1895 edition of the one-inch map. Most of the parishes are now entire, but a few have detached portions lying considerable distances apart. The boundaries of the parishes have remained substantially unchanged, in spite of minor alterations, from a very early period, and normally each parish contains a single village grouped round the parish church. The parishes appear to have grown naturally until they filled up the county; it cannot be said that the county has been *divided* into parishes, as the relation of the boundaries to natural features shows. The parishes are grouped into thirteen larger divisions—*hundreds*—and these in turn form parts of larger divisions peculiar to Sussex, and called *rapes*. The rapes run from south to north, and are approximately equal in area. Those represented on the sheet are the Rapes of Chichester, Arundel, and Bramber. The Rape of Chichester includes seven hundreds, named respectively Aldwick, Bosham, Box and Stockbridge, Dumpford, Easebourne, Manhood, and Westbourne and Singleton. The Rape of Arundel includes five hundreds, viz. Avisford, Bury, Poling, Rotherbridge, and West Easwrith, and all of these are represented on the sheets; but of the twelve hundreds which compose the Rape of Bramber, there are parts of only three, Brightford, East Easwrith, and Patching. The divisions are not marked upon the Ordnance Survey maps. The more important, but also unmarked, grouping of parishes into registration districts and subdistricts is used for statistical purposes.

On the coastal plain the parishes have remarkably irregular boundaries as marked on the map. For a considerable part they are bounded by rivers or streams, hence the borders are winding. In the case of South Bersted and Felpham the parish boundary leaves the river at two points, describes a curve, and returns to the stream. These probably perpetuate former river windings which have been deserted by the water since the boundaries were fixed. East of the Arun the eastern and western parish boundaries are, as a rule, nearly straight lines drawn at right angles to the coast. In the flat gorge of the Arun where it cuts through the Downs, the curious alternate allocation of the valley flats to parishes on the east and west is the result of using as a boundary a river which in its windings runs close against the steep banks of the valley alternately on the right and left (Fig. 14). This may also be one of the reasons that prevented a north and south road from running through the Arun valley; it would have had to pass through seven parishes in 5½ miles, and there are signs in many of the parishes on these sheets that the roads were originally constructed for the purposes of the parish alone, and seem reluctant to cross from one to another. In the south of the Chalk area the parish boundaries frequently run down the crest-lines of ridges, leaving a whole valley or group of valleys to form the parish. Occasionally, however, the boundary is a

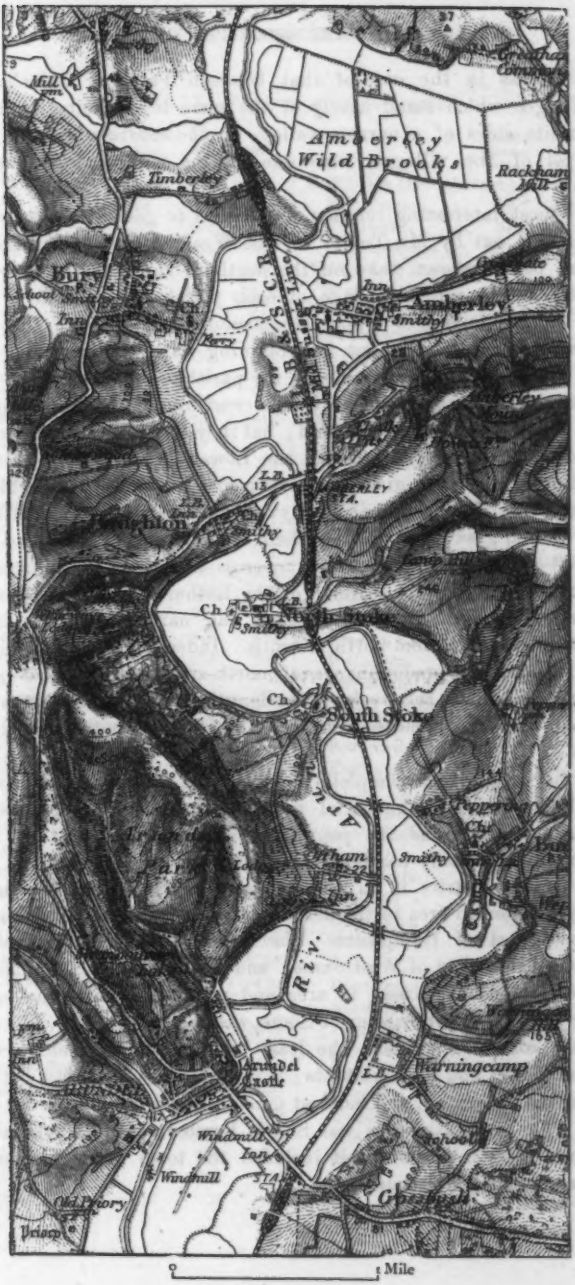


FIG. 14.—THE ARUN GORGE, SLIGHTLY ENLARGED FROM THE ORDNANCE SURVEY 1-INCH HILL-SHADED MAP.

valley-line, as in the case of that between Patching and Clapham, two villages which stand nearly at the same level, facing each other on opposite sides of a narrow valley, up the centre of which, below the level of the villages, runs one of the minor roads over the Downs.

The most interesting relation of parishes to geological structure is that pointed out by Mr. Topley for the Wealden area as a whole, but nowhere better shown than on the northern slope of the Downs in Sheet 317. The central village of each parish from Elsted to Bury stands on the terrace of Upper Greensand at the base of the Chalk escarpment, a site convenient for obtaining water by means of wells. As the villages were planted closely, the parishes are all narrow. They run straight up the escarpment to the crest-line of the Downs, giving to each a portion of pasture ground; but they also run each as a narrow strip across the belt of Gault and the Lower Greensands down to the valley-line of the river, giving to each parish a share of the arable and grazing lands. In the Bignor embayment, the parishes radiate like the ribs of a fan, gradually shifting their length from a north-and-south to an east-and-west direction, so as to cross the strike of the strata at right angles (see Fig. 13). North of the Rother the sheet only shows portions of parishes alternately broad and narrow, but all having their greatest length from north to south. Indeed, in the whole district under review, the predominance of north-and-south lines as parish boundaries, and the relatively great length from north to south as compared with the breadth from east to west, are noticeable characteristics.

The list of parishes completely included in the sheets is given in Table IX., with the number of inhabited houses and population at the census of 1891, and the population at the census of 1881. The parishes which are only partially included are given in Table X.

The whole district is in the ancient county of Sussex, though formerly a detached area in the north-west—the parish of South Ambersham—was part of Hampshire. The whole now forms part of the administrative county of West Sussex and of the diocese of Chichester, while it corresponds closely in area and population with the parliamentary division of Chichester or South-west Sussex.

Of the complete parishes, the least populous is Middleton with 7 inhabited houses and 40 inhabitants; it is situated on the coast between Felpham and Climping, and has lost much of its original area by coast erosion. The most populous was South Bersted, with 995 inhabited houses and 4953 inhabitants; it included the town of Bognor, which now forms a parish by itself.

TABLE IX.—PARISHES WITH POPULATION.

	Inhabited houses. 1891.	Population. 1891.	Population. 1881.
Midhurst District—			
Elsted	40	191	208
Treyford	23	114	147
Didling	14	61	85
Bepton	49	263	269
Cocking	90	449	574
Heyshott ...	91	393	448
Graffham ...	84	407	413
East Lavington ...	36	191	221
Selham	8	48	49
West Lavington...	47	218	151
Midhurst ...	334	1674	1615
Petworth District—			
Egdean	17	75	76
Fittleworth ...	159	761	696
Stopham	32	151	156
Coates	15	84	61
Bury	114	531	517
Bignor	25	127	154
Burton	11	57	73
Sutton	63	325	310
Barlavington ...	32	175	182
Duncton	55	259	268
Thakeham District—			
Coldwaltham ...	83	338	389
Greatham ...	12	66	59
Hardham ...	23	124	101
Wiggonholt ...	7	52	38
Amberley ...	114	525	570
North Stoke ...	21	100	103
Rackham ...	29	134	161
Parham	12	58	88
Storrington ...	246	1293	1351
East Preston District—			
Houghton ...	38	174	196
South Stoke ...	24	131	133
Arundel	550	2644	2748
Tortington ...	58	288	165
Ford	20	102	100
Climping ...	54	251	270
Burpham ...	52	280	286
Warningcamp ...	34	159	128
Lyminster ...	357	1693	1587
Poling	43	178	180
Angmering ...	210	1014	982
Patching ...	55	270	274
Ferring	54	226	232
Kingston ...	12	43	34

	Inhabited houses. 1891.	Population. 1891.	Population. 1881.
E. Preston District (*cont.*)—			
East Preston ...	57	414	420
Rustington ...	91	434	360
Littlehampton ...	851	4452	3926
Westbourne District—			
West Dean ...	120	611	734
New Fishbourne	79	323	316
Chichester District (complete)—			
Chichester (10 parishes) ...	1553	7887	8529
West Hampnett District (complete)—			
West Stoke ...	20	103	95
Lavant	157	787	805
Binderton ...	21	110	100
Singleton ...	121	579	555
East Dean ...	73	303	343
Up Waltham ...	16	67	82
Slindon	113	539	507
Madehurst ...	31	176	190
Binsted	20	103	135
Walberton ...	126	628	607
Eastergate ...	34	174	161
Aldingbourne ...	171	798	743
Tangmere ...	45	164	185
Boxgrove ...	162	699	708
Eartham ...	27	138	154
Oving	443	1973	1662
West Hampnett	79	505	521
Rumboldswyke ...	358	1497	902
Hunston	43	187	176
Appledram ...	31	144	159
Birdham ...	95	453	455
Earnley	26	140	132
Sidlesham ...	199	920	946
Selsey	228	1039	901
Donnington ...	36	191	188
North Mundham	86	373	401
Pagham	197	887	874
Merston	24	108	96
South Bersted ...	995	4953	4166
Barnham ...	46	230	184
Felpham ...	167	724	565
Middleton ...	7	40	44
Yapton	139	660	556
Total	10,531	51,183	49,429

TABLE X.—PARISHES PARTS OF WHICH ARE INCLUDED IN SHEETS 317 AND 332, WITH ASSUMED POPULATIONS.

	Inhabited houses (estimated). 1891.	Population (assumed). 1891.	1881.
Midhurst District—			
Terwick	2	10	10
Trotton	46	230	206
Iping	21	105	105
Stedham	50	250	242
Woolbeding ...	12	60	60
Easebourne ...	40	240	170
South Ambersham	30	160	106
Lodsworth ...	12	60	64
Tillington ...	105	525	534
Petworth District—			
Petworth ...	520	2600	2670
Wisborough Green	19	95	96
West Hampnett District—			
East Wittering ...	16	80	86
West Wittering ...	6	30	33
Thakeham District—			
Pulborough ...	286	1430	1450
West Chiltington	100	500	530
Sullington ...	26	130	123
Thakeham ...	25	125	138
East Preston District—			
Clapham	28	140	125
Goring	8	40	38
Westbourne District—			
Bosham	80	400	400
Funtington ...	70	350	380
Stoughton ...	2	10	10
East Marden ...	5	25	30
Total for portions	1509	7595	7606

There are also very small parts of the following parishes, but with no population: Finden, North Marden, Harting, Rogate, and Chithurst.

Place-Names.—The names on the sheets under notice are typically and almost exclusively Anglo-Saxon. The two commonest terminations are *-ton*, which occurs in forty-seven cases, and *-ham*, which occurs in fifty. Both these suffixes signify an enclosure or dwelling-place, and other terminations of nearly identical meaning, such as *-worth* and *-borough* or *-bury*, are not uncommon. The termination which comes third in the list is *-ing*, of which there are twenty-four examples. This is the Anglo-Saxon equivalent to the Keltic *Mac* or *O'*, and indicates the settlement of a family or clan, equivalent nearly to the possessive case so common in the farm-names of the district at the present day. Personal names for places prevail; terminations descriptive of natural features are much less common. There are fourteen *-dens* or *-deans*, eleven *-hursts*, and a few *-holts;* referring to the woods, ten *-wicks* or *-wykes;* eight *-fords* and five *-bournes*, referring to the waters. The names indicate the early and complete settlement of the district by the Saxons, the old Roman names, which must have been numerous at one time, and the earlier Keltic names having almost entirely disappeared.

Distribution of Population.—The sheets under consideration represent an area of 270 square miles of land, and the population at the census of 1891 is estimated as follows:—

	1891.	1881.	Difference.
83 complete parishes (counting Chichester as *one*)	51,183	49,429	+1754
Portions of 23 parishes (estimated)	7595	7606	− 11
Total probable population on sheets ...	58,778	57,035	+1743

This gives an average density of population of 218 per square mile in 1891, and 211 in 1881. But if the uninhabited part of the country is defined as any part more than an eighth of a square mile in area, the border of which lies more than a quarter of a mile distant from the nearest dwelling, there are 34 square miles of uninhabited country in the sheets, leaving 236 square miles of inhabited country, the average density of population upon which, in 1891, was 249 per square mile, that of all England being nearly 500.

TABLE XI.—DISTRIBUTION OF POPULATION IN 1891 BY ELEVATION.

Zone: Feet.	Area. Sq. miles.	Population. Total.	Density of Population per sq. mile.	No. of towns.	Villages.
Over 600	6·0	6	1	—	—
600–500	9·5	20	2	—	—
500–400	15·5	175	12	—	1*
400–300	20·0	518	26	—	2†
300–200	9·0	3,067	341	—	16
200–100	66·0	10,959	166	1	23
100–50	43·0	7,455	173	1	21
Below 50	101·0	36,634	361	4	77
Total ...	270·0	58,834	218	6	140

According to altitude, the population is distributed as shown in Table XI. This shows that the upper part of the Downs above 500 feet are practically uninhabited, and that only one very small village, or rather hamlet, Madehurst, stands at an elevation exceeding 400 feet, and only three villages above 300 feet.

It is remarkable to observe how the density of population suddenly increases from 26 per square mile for the zone between 400 and 300 feet to 341 per square mile for the narrow belt between 300 and 200 feet. The reason of this is found partly in the configuration and partly in the geology. On the southern slope of the Downs there are only two villages, Eartham and Slindon, within this zone. Three of the important villages of the central valley (West Dean, Charlton, and East Dean) help to swell the population, together with the scattered farms which the coating of drift makes possible between the bordering hills of Chalk. But the distinguishing feature is the terrace of Upper Greensand at the base of the great Chalk escarpment. The western half of this terrace occupies the zone of height between 300 and 200 feet almost exactly; farther east, where the Greensand has been worn down lower, the villages it carries stand below 200 feet. The zone includes part of Elsted, the whole of Treyford, Didling, Bepton, Cocking, part of Heyshott,

* Madehurst. † Up Waltham and Elsted.

Graffham, Barlavington and Sutton. They are all agricultural villages, without industry, and, as indicated when speaking of the parishes of which they are the centres, they are placed on the water-bearing strata and arable soils between the pastures of the Downs and the grazing lands of the Gault and Lower Greensand valley.

The next zone, from 200 to 100 feet, contains one or two of the Upper Greensand villages, especially Bignor and West Burton; several on the northern side of the Rother valley, including Petworth, Fittleworth, Stedham, and Trotton; and a good many on the southern slope of the Downs, viz. West Stoke, the three Lavants, Waterbeach, Halnaker, Patching, and Clapham. The main development of this zone of altitude is in the valley north of the Downs, on the Gault and the infertile soils of the Folkestone Beds of the Lower Greensand, where farms are widely scattered, and from which the villages have been attracted either to the Upper Greensand terrace, or to the left bank of the river.

The zone of elevation between 100 and 50 feet contains parts of Midhurst and Pulborough on the north, and a few villages near the high-road between Chichester and Arundel on the south; but it has practically the same density of population as the zone above.

Below 50 feet the density of population comes to a maximum, partly because it contains the largest towns—Chichester, Littlehampton, Bognor, and most of Arundel—but partly also because of the great fertility of the coastal plain, the absence of woodland or commons, and the large number of small farms into which it is divided. The Arun valley also has a double chain of villages, one, as a rule, encircled by each bend of the river, and each built upon a fragment of an old river-terrace left higher and remaining dryer than the swampy meadows through which the stream meanders (compare Figs. 7 and 14).

The uninhabited areas include three small patches of very low-lying alluvium (compare Figs. 7 and 9). One stretches from the reclaimed ground of Pagham harbour round the north of the gravel ridge on which Selsey stands, and this recently reclaimed tidal marsh is crossed by only one high-road. Another of smaller area lies in the depression—much of which is below high-water level—between the disused Chichester and Arundel canal and Bognor, and is crossed by no road at all, although the Bognor branch-line runs through its western margin. The third uninhabited alluvial tract lies between Wiggonholt and Pulborough, on the great expansion of the Arun valley bottom, which is subject to floods every winter.

The main body of uninhabited land is formed by the Downs, along which it is possible to walk from one end of the sheet to the other, and even to cross the Arun valley, without passing within a quarter of a mile of an inhabited house. Thus the population may be said to be separated by the uninhabited Chalk Downs into a densely inhabited plain on the south, and a much less densely peopled valley on the north.

In attempting to get actual statistics for these regions, the groups of parishes employed for the discussion of agricultural statistics yield the following result:—

TABLE XII.—POPULATION GROUPED IN AREAS.

Group of parishes.	Area of group. Sq. miles.	Total population. 1891.	Density of population per sq. mile.
Wholly on the Chalk	55·8	6,551	117
Partly on and *partly south* of Chalk	20·3	2,603	128
Wholly south of the Chalk	88·2	34,446	391
Partly on and *partly north* of Chalk	52·4	5,765	110
Wholly north of the Chalk	34·1	6,184	181
Total	250·8	55,549	221

In this grouping, the parishes "wholly on the Chalk" include the tongues of Tertiaries and drift that run up into the valleys from the south, and the alluvium of the Arun gorge where it crosses the Downs, and it is on these, and especially in the town of Arundel, that the population is found. The interesting contrast is between the fertile coastal plain, which supports a population of nearly 400 per square mile, the Chalk, which, if Arundel be excluded, has a population under 10 per square mile, and the less fertile valley of the Rother, where the population is under 200 per square mile.

Vital Statistics and Movement of Population.—The population increased by 1743 inhabitants, or 3 per cent., in the ten years between 1881 and 1891; the rate of increase for the whole county of Sussex in the same period was 12 per cent. Hence it would appear that, taken as a whole, this district is nearly stationary as regards population. The difference between births and deaths (on the basis of the year 1897) would produce an increase of 0·8 per cent. per annum, and as the average increase was only 0·3 per cent. per annum, the emigration from the area in question must amount to about 0·5 per cent., or say 300 persons every year. A definite decrease in population is found in most of the parishes in the Rother valley and on the Downs, the increase being mainly confined to the parishes on the coastal plain (Fig. 15). The greatest increase is found in the parishes of Littlehampton and South Bersted (which included Bognor at the time of the census), and also in Rumboldswyke and Oving, which contain suburbs of Chichester lying outside the municipal boundaries. The actual population of both Chichester and Arundel showed a decrease of about 4 per cent.

The Registrar-General's Report gives for each year the number of births, deaths, and marriages arranged for each county according to registration districts and subdistricts, but the parishes are grouped to form these in such a way that it is very difficult to bring the

statistics into relation with the natural divisions. Table XIII. gives the statistics for 1897 relating to the subdistricts, which most nearly fill up the region under consideration, and represents a total of 54,293 inhabitants living on 221 square miles, *i.e.* with a mean density of 245.

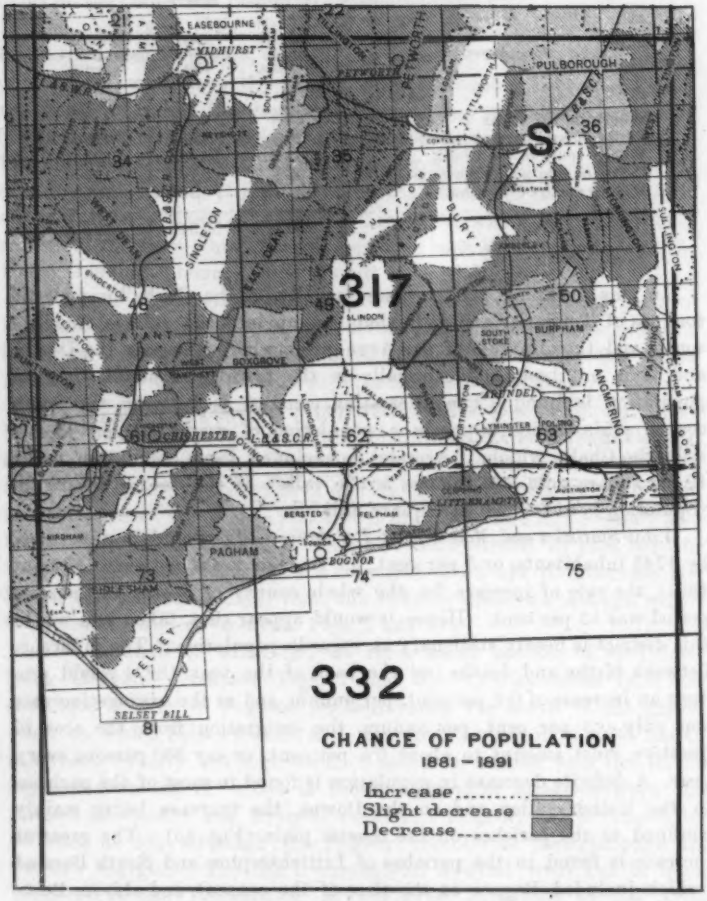


FIG. 15.—MAP SHOWING INCREASE OR DECREASE OF POPULATION BETWEEN 1881 AND 1891.

Table XIV. shows the same figures calculated as ratios of the population in 1891. These ratios are, of course, not quite accurate for 1897, although in most cases the divergence from accuracy is probably small, as the changes in the population are slight except in the growing towns on the coast.

TABLE XIII.—POPULATION STATISTICS FROM REGISTRAR-GENERAL'S REPORT FOR 1897.

Registration District.	Registration Subdistrict.	Area, acres.	Square miles.	Popn. 1891.	Births. Total.	Births. Illeg. No.	Deaths. Total.	Marriages.
Petworth ...	Petworth, South	20,456	32	5,412	110	5	54	31*
East Preston	Littlehampton	8,927	14	7,899	240	18	163	53*
" ...	Arundel	16,007	25	4,628	138	1	70	31*
Westhampnett	Oving	40,501	63	5,434	122	5	75	145
" ...	Bognor			4,953	123	6	78	
" ...	Yapton			4,064	87	1	60	
" ...	Boxgrove	17,641	27	2,304	43	5	58†	
" ...	Singleton	12,618	20	1,949	41	2	27	
Chichester ..	—	1,888	3	10,815	297	15	221	83
Midhurst ...	Midhurst	23,810	37	6,835	161	10	99	32*
Total ...	—	141,848	221	54,293	1362	68	905	375

TABLE XIV.—POPULATION RATIOS, 1897.

Registration Subdistrict.	Density of population 1891, per sq. mile.	Per 1000 of population in 1891. Births.	Deaths.	Marriages.	Excess of Births over Deaths. Number.	Per 1000 population in 1891.	Per cent. of total births.	Illegit. Per cent. of total births.
Petworth, South	169	20	10	6	56	10·3	51	4·5
Littlehampton	564	30	21	6	77	9·7	32	7·5
Arundel ...	185	30	15	7	68	14·7	49	0·7
Oving	229	22	14	8	47	8·6	38	4·1
Bognor... ...		25	16		45	8·3	36	4·8
Yapton ...		21	14		27	6·6	31	1·2
Boxgrove ...	85	19	25	8	−15	−6·5	−35	11·6
Singleton ...	97	21	14		14	7·1	34	4·9
Chichester ...	3605	27	20	8	76	7·0	25	5·0
Midhurst ...	131	23	14	5	62	9·0	39	6·2
Average ...	245	25	17	7	457	8·0	33	5·0

The relatively high birth rates and death rates of the subdistricts Littlehampton, Arundel, Chichester, and Bognor are possibly due to increase of population since 1891, and the low rates in the other districts may similarly be to some extent due to the drift of population from the country. The remarkable excess of births over deaths in Arundel and Petworth (practically 50 per cent.), and the low excess in Chichester (only 25 per cent.), have possibly some cause connected with the conditions of hygiene in the towns of the districts. The excess of deaths over births in Boxgrove is probably an accident of the year, the small population of that subdistrict depriving it of any statistical value.

* The marriages being only given for registration districts, those of the subdistricts are estimated on the assumption that the rate was the same for the whole district.

† Of these forty were of males and eighteen females. In no other division did the proportion of the two sexes dying differ sensibly from equality.

Perhaps the most remarkable regional distribution shown by these tables is in connection with the proportion of illegitimate to total births. The average for the whole area is 5 per cent. (that of the county of Sussex 5·3 for 1897, and 5·4 as an average of ten years), and only four subdistricts vary significantly from this proportion. Of these, Boxgrove, with 11·6 per cent., may be disregarded on account of its small population. But Littlehampton, with 7·5, stands in marked contrast to the adjoining districts of Arundel and Yapton with 0·7 and 1·2 respectively. It is unfortunate that no statistics of religious belief exist, but it is known that a very large proportion of the inhabitants of Arundel are Roman Catholics.

Towns and Villages.—The city of Chichester is built on the level plain, near the head of the riverless inlet known as Chichester Channel,

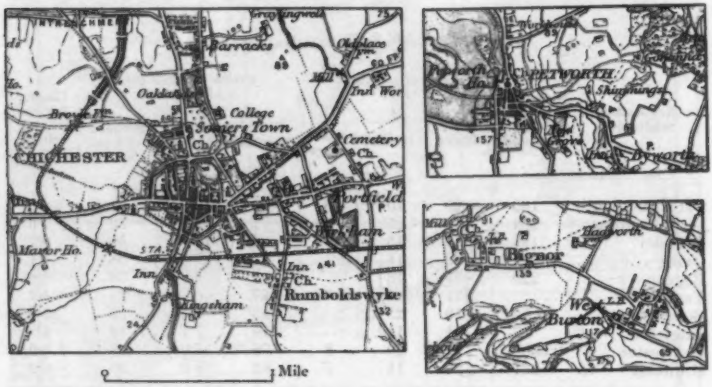


FIG. 16.—PLANS OF TOWNS AND VILLAGES FROM THE 1-INCH ORDNANCE SURVEY MAP.

which formerly furnished a harbour for small vessels, but Chichester can now scarcely be viewed as a maritime town. Its position due south of the opening of the Lavant valley can hardly be due to the road running through it to the north, because the Romans built the road from their station at Chichester (Regnum) in a straight line to the north-east over the Downs. The original plan of the city is outlined by a north-and-south road crossed at right angles by an east-and-west road, and surrounded by a circular wall, beyond which the roads diverged. New building has carried the streets beyond the old wall, but the original plan remains (Fig. 16). As a cathedral city (since the time when Selsey cathedral was abandoned in 1078), Chichester has a certain amount of general business, but there are no manufactures. The city is supplied with water derived from wells sunk in the Chalk at Old Fishbourne, and pumped up to a reservoir just north of the town, whence the supply is distributed by gravitation.

It is curious to note that, except for Old and New Fishbourne, which are now practically suburbs of Chichester, the high-road along the coastal plain does not run through a single village.

Arundel probably owes its existence as a town to the fine site it afforded for a castle in ancient times by commanding the break in the Downs at a point where the navigable tidal river ran close against the Chalk hillside. Here the river was first bridged, the village named Ford, halfway to the sea, marking what may have been the only other crossing-place on the coastal plain. Even now no roads cross the Arun below Arundel, whence one road runs on the right bank to Ford, Climping, and Atherington, and another, at least a mile east of the river, to Lyminster, Wick, and Littlehampton.

Littlehampton, at the mouth of the Arun, is the one actual seaport in the district under consideration, but it is only accessible at high water, vessels taking the ground as the tide falls. The river was formerly of importance for steamer trade with France, but since 1880 the volume of shipping entering the port has been reduced to less than one-half. Although over 400 vessels entered and cleared in 1894, their average burden was under 90 tons, and no vessel of over 500 tons can enter. The town is supplied with water from deep wells sunk in the plain to the north. The present importance of Littlehampton arises less from its shipping than from its beach (Fig. 5), which makes the town attractive as a bathing-place and summer residence. The track of sand-dunes west of the river has given rise to golf-links, which increase the attractions to visitors.

Bognor has also become a town by taking advantage of its fine beach to attract summer visitors. The beach is protected by a promenade and sea-walls for over a mile. Connected already by a good and direct road with Chichester, its development had well begun before the branch railway brought it into rapid communication with the outside. The water-supply is derived from wells sunk in the Chalk at Eastergate, 5 miles to the north.

Many other points along the coast might, but for the difficulty of access due to the indirect roads, have formed the sites of similar watering-places. Pagham, originally a fishing village with a large tidal harbour, has dwindled in importance, and the site of the harbour has been reclaimed. Selsey is built on a ridge of marine gravel, which rises above the general level, and is separated from the mainland on the north by a broad stretch of low alluvial ground, once a tidal lagoon connected with the sea on both sides, hence the name of the parish, Selsey, or Seal-island. The village is still of some importance for fishing, a number of boats being employed in catching lobsters. Selsey enjoys a unique position on the south coast of England for exposure to sea-air. From every point of the compass round three-quarters of the horizon the wind blows from the sea, only between

N.E. by N. and N.W. by W. does it come over the land. Hence, as there is a good and direct road from Chichester, Selsey was growing so rapidly in importance that the Hundred of Manhood and Selsey steam tramway was constructed from Chichester to Selsey beach in 1897.

While there are no villages on the east-and-west high-road between Chichester and Arundel, or on the railway line, it is interesting to notice that the disused Chichester and Arundel Canal runs through a chain of villages—Donnington, North Mundham, Merston, Colworth, Lidsey, Barnham, and Ford, each being situated at the point where a north-and-south road crosses the canal.

The general plan of all the villages in the district is a cluster of houses about the meeting place of local roads; they are as a rule compact groups, not straggling along the highway as villages which have grown round inns or halting-places on through roads usually do. In most cases the roads which meet do not run through the village, but join a rectangle or ellipse of roads, this being typically shown in Bignor and West Burton (Fig. 16). The advantage of a site on the Upper Greensand terrace is sufficient to explain the garland of villages which surrounds the northern face of the escarpment of the Downs. In the Arun valley the want of a through road except by water ensured the long isolation of the villages built on the fragments of old river terraces between the steep chalk hills on one side and the swampy bottom lands on the other (Fig. 14). But in the Lavant valley, the line of communication afforded by the road between Chichester and Midhurst is undoubtedly the cause which gave importance, if not existence, to Cocking and Singleton. The former naturally arose on the Greensand terrace at the foot of the steep ascent to the pass in the Downs, where men and horses would naturally rest before tackling the most arduous part of the journey. Singleton would naturally form a halfway house both for traffic on the main road and on the less-frequented branch road by Up Waltham. The traffic on these roads no doubt owed much to the establishment of a racecourse by the owner of Goodwood Park.

Pulborough has also a position rendered important as a crossing-place of roads. The ancient Stane Street crossed the Lower Greensand escarpment, as it crossed that of the Chalk, ignoring the Greensand gorge of the Arun, which remains without either a road or railway to this day. Where Stane Street was crossed by the road along the northern bank of the Rother, that road had to keep close to the side of the east-and-west ridge which looked out over the widened portion of the Arun valley bottom which is subject to floods, and here Pulborough arose, the position being given a fixed value in railway days by the junction between the main line and the Midhurst branch.

Petworth (Fig. 16) and Midhurst are both formed by a cluster of houses grouped round two main roads converging from the south so as to form one passing northward, and they have thus a roughly triangular plan.

Probably both towns owed their importance to the castles surrounded by great parks, which must have served as a nucleus for settlements afterwards made prosperous as market-places for the surrounding agricultural district. Midhurst may also have derived some advantage in pre-railway days from being the head of barge-navigation on the Rother, the trade on that river having been sufficient to lead to its canalization.

Industries.—Agriculture, and the rearing of live-stock, especially sheep and cattle, are almost the only occupations of the district. The various towns have all markets weekly or twice weekly, and next to farming most people are employed in local trade, the supply of agricultural requirements, and such necessaries as are not worth bringing from London to the various country seats whose parks occupy a considerable area on the Downs and in the northern valley. Mineral resources are worked for local purposes. Iron in the Folkestone Beds, formerly a source of prosperity, has not been worked for a hundred years. Chalk-pits gleam amongst the green turf of the escarpment of the Downs and on the walls of the Arun gorge (Fig. 10); phosphatic and siliceous deposits are dug in the Upper Greensand for use as fertilizers. The Lower Greensands supply stone adapted for road metal and for building purposes. Flints are collected from the chalk-pits and from beneath the turf on the Downs and utilized for road-metal and for building purposes, along with bricks made from the brick-earths of the coastal plain at Rustington and elsewhere. The flints when first dug are too brittle for use, but after a few years' exposure to the weather become tough and durable. Large heaps of flints spread out to weather are to be seen on the Downs. Many of the buildings on the plain are constructed of brick and flint, the brick forming a sort of framework which is filled up with flints set in cement, while in the Rother valley timber and brick houses prevail. The common roofs are thatch, and very often the slope of the roof is carried down nearly to the ground on the windward side, as a protection against rain.

Windmills are common on the coastal plain, and it seems reasonable to expect that the exposed crests of the Downs might be utilized for the erection of wind-engines of modern type, which might at reasonable expense provide electric light for Chichester, Arundel, and many other villages, and thus make up for the absence of water-power and of coal.

Fishing is only pursued on a small scale, the catch of lobsters being the most important.

Probably a leading source of employment is now the catering for summer visitors in the watering-places of the coast, and during the annual race-meeting at Goodwood. Several almshouses and convalescent homes, supported by metropolitan charities, are situated near the sea-coast.

Before the reading of the paper Sir CHARLES WILSON, Vice-President, said: Some seventy years ago, when the 6-inch Ordnance Survey of Ireland commenced, a very elaborate scheme of parish memoirs was devised, I think on the initiative of Sir Thomas Larcom, for the whole survey. A great deal of information was collected throughout the whole of Ireland, but unfortunately, after the memoir on one parish had been published, the Treasury got frightened at the expense, and the whole scheme was abandoned. However, in the mean time a great deal of valuable information had been obtained, nearly every object of archæological interest in Ireland had been carefully drawn and planned, and the data then collected by the officers of the survey now form not the least of the valuable collections in the Royal Irish Academy. A few years ago, on the completion of the survey, it was suggested that memoirs should be published for each sheet of the Ordnance Survey map, partly on the lines of the memoirs of the Irish survey. A committee was appointed by this Society, and Dr. Mill kindly undertook to prepare a specimen memoir. It is this memoir, which I am sure will be most interesting, that we are to listen to to-night.

After the reading of the paper, the following discussion took place:—

Colonel JOHNSTON (Director-General of the Ordnance Survey): I have really but few remarks to offer on the excellent paper you have heard from Dr. Mill. He has managed to give you a most interesting account of the geography, the geology, and the various other facts connected with this part of England. So far as the work of the Ordnance Survey is concerned, he has been good enough to speak in flattering terms, and I can only say the Survey is anxious to do the best it can in the way of mapping out the country generally, and if we could only get a certain amount of interest shown in the survey in the way Dr. Mill has indicated, I believe the maps would be very much more useful than at present. The great difficulty, as far as one can judge, is that in the country generally there is a very large amount of ignorance as to what the Survey does and what it ought to do, and this can be remedied in no better way than by the reading of such excellent and interesting papers as Dr. Mill has prepared, which I feel certain will do much to increase interest in the survey.

Prof. LAPWORTH: Dr. Mill has spoken so clearly and so eloquently on this subject, that he has left me very little to say; but I understood that I was going to hear a geographical paper read; on the contrary, I have listened to what I should call an exceedingly interesting geological lecture. I don't complain, for I have asserted again and again in public and private that geology and geography are one. Dr. Mill shows us distinctly that it is impossible to fully understand the configuration of the country, its scenery and the distribution of its population, its history, or indeed many of its characteristics, unless you have first got a grasp of the geology. Once you get that, everything falls into its place, and all becomes clear. As Dr. Mill is present, I may tell you a secret. I have read Dr. Mill's paper this evening with the greatest pleasure, but not a word of the geological introduction is in the paper. Now, the plan, which has been sketched out by the committee, purports, I take it, to be a geographical description of the various survey maps of England for the benefit of the inhabitants of the district that the survey map illustrates. I take it that the committee propose that this first paper, which will be published soon, I hope, in the Geographical Society's *Journal*, is the model upon which the others will be framed. Dr. Mill has risen to the occasion, and has shown us what kind of guide we want. His lecture was alive with interest and enthusiasm, and it taught us the reason why of the geography and statistics of the country. His paper bristles undoubtedly with facts and statistics, but I must confess that I should like to see that paper commence

with an introduction like that which Dr. Mill gave us to-night, and I would urge that every guide should commence with such an introduction. The Geological Survey of North America has been issuing lately a series of areal maps giving the geography and geology of certain districts. At the commencement is a description of each, giving a summary of those geological principles which enable the reader to understand the map. I would urge the committee to do this in the case of the publication of every one of their guides. It may be said that many will repeat themselves; this is not so. The illustrations brought forward by Dr. Mill were peculiar to the district he was describing; there are, of course, geological principles that affect all the world equally, but they are illustrated in every case by the geographical area under description, and they do not apply in quite the same way to any other geographical area in their entirety. Perhaps, if you will allow me, I may give an example. In my own district of Birmingham, we, as in Sussex, have three distinct geological formations. We have our coal measures, our red sandstone, and our marl, answering to the three in Dr. Mill's paper; but how differently do they behave, how differently do they affect the history and characteristics of the people! Our lowest formation forms the great coalfield of Staffordshire, then follow the pebbly beds and waterstones, and answering to your plain is the plain of central Warwickshire, a plain of marls. All three are intimately bound up with the whole history of the midlands. The old forest of Arden, the plain of marls, in the ancient times was sparsely inhabited, overrun by deer, the district had very few villages, but at the edge of it the waterstones were everywhere rich in springs, exactly as in the sandstones of Sussex, and they were the sites of the ancient villages and the old castles. At the present day the chief towns of the midlands are built upon them. Curiously enough, this marly plain had a very great influence upon our literature. It was in that quiet wooded plain that Shakespeare lived and wrote. It was the district of George Eliot. I might go on to show you how to the existence of the great coal-measure sheet the pushing and forward movement of the midlands at the present day is due. But to come back to the point of departure, it appears to me in Dr. Mill you have the very man to work out your most excellent scheme. If he could be persuaded to give a public description like the one which he has given to-night before publishing a guide to each district, and were a reporter engaged to take it down, the diagrams copied, and the whole summarized as an introduction, the cost need not be great, and I have no doubt that the guides would sell well and do a great amount of good.

Mr. J. E. Marr: I beg to differ from my friend, Prof. Lapworth. I cannot think Dr. Mill's paper pure geology. There are no two sciences more strongly welded together, and, in a way illustrating what biologists term commensalism, each science receives support from the other: that is shown in a general way in the very district described to-night. The structure of the curious valleys of this area was illustrated and rightly from the purely geological point of view; it was supposed by many that that structure was exceptional, but it was subsequently for geographers to prove that this was an illustration of one of the most important laws of geography. Dr. Mill has shown you in detail that the two sciences must work together in future. Two years ago Dr. Keltie, the president of the Geographical section of the British Association at Montreal, by his presidential address, brought a blush to the cheeks of geologists and geographers when he pointed out that the geography of the Mother Country was not yet worked out. Dr. Mill has begun this work, and I hope that now it has been so successfully begun it will be carried out through the country. I can assure geographers that geologists will give every assistance in their power. Lastly, I must congratulate Dr. Mill on the admirable way he presented his paper. We have heard papers in which the language was so technical as to remind us of

the remark made by the late head-master of a public school, who, where an under-master would remark, "Don't laugh quite so loudly," said, "Young gentlemen, when inclined to risibility, let your cachinnation be like the corruscations of æstival electricity—lambent, but innocuous."

Major CRAIGIE: I attended with the greatest pleasure to hear the lecture Dr. Mill has given us, and was interested in discovering how far the results of our agricultural statistics tally with other information derived from geology and other sources brought before Dr. Mill in his preparation of the general scheme of the guide; and it is certainly very satisfactory to see that the results reflected in the returns have followed the general details of the country, especially as indicated by its geological character, with very great precision, and perhaps the crop yields have reflected more clearly than any other feature the dominating character of the geology of western Sussex in its three great divisions on their agricultural characteristics. I hope, as this work proceeds, that Dr. Mill will find such statistics as we may be able to give from the Agricultural Returns more and more increasingly useful, and that, as Colonel Johnston expressed it, we may popularize both these and the Ordnance maps of the country, in the way we have heard to-night, as indispensable materials for our local geography.

Mr. G. G. CHISHOLM: I came unprepared to say anything, but I have had the very greatest pleasure in being present on this occasion to hear the first instalment of an important work that was planned by Dr. Mill a few years ago. I am one of those who are, like Mr. Marr, unable to coincide with Prof. Lapworth in stating that geography and geology are exactly the same science, that geography is in fact nothing but one of the aspects of geology. The fact is, of course, that geography must bring into account the facts with which geologists provide us, but at the same time, perhaps unfortunately for geographers, they have to take into account a great deal besides—facts from climatology, mineralogy, chemistry, and other sciences; in fact, I am often reminded, in thinking of the ideal equipment of a geographer, of the description given of Dr. Whewell by Sydney Smith, "Science was his forte; omniscience was his foible." Now, it would almost seem as if geographers were compelled to profess omniscience, so much is embraced by the study. To illustrate the difference between geography and geology, I may mention one fact suggested to me in the course of this paper, that distinctly belongs to geography and not geology. In describing the town of Chichester, Dr. Mill said the two main streets were exactly at right angles with each other. Now, it occurred to me, seeing that Dr. Mill had suggested that Chichester was probably the Roman city of Regnum, and I believe that is generally admitted, that these two streets have followed the original alignment of this Roman foundation, because we know that when the Romans founded colonies in various parts of the world, they, as a civilized power, had learned the great convenience of having straight streets at right angles, and they did exactly as we are in the habit of doing at the present day, laid out the streets in that way. Every Roman colony had one main street in one direction, and another of a certain relative breadth at right angles to it, and the other streets parallel to these, with the same regularity as we see in Washington, Adelaide, Melbourne, Buenos Aires, St. Petersburg, and other towns laid out by modern civilized peoples.* I do not know whether Prof. Lapworth will accept this

* An illustration of the regularity of building of cities deliberately planned as distinguished from such as, so to speak, grew up of themselves, from an earlier date than the colonizing days of the Romans, is given by Strabo, who mentions that Nice, in Bithynia, founded by Antigonus, was built in the form of a square, and with such regularity that one standing on the middle stone of the gymnasium could see all its four gates at once.

trifling illustration of the difference between us, but I am at least sure that he will excuse the difference of opinion, when I add that on what is the main point for this evening, the great interest and value of the paper we have just heard, I heartily agree with him, as I am entirely at one with Mr. Marr as to the admirable and really fascinating manner in which that paper has been laid before us.

Mr. G. J. Symons: I think we have had a treat; in fact, we always have a treat when Dr. Mill reads a paper, because it is made so much more interesting by his facility of speech; he illustrates his paper so well, and I quite understand why Prof. Lapworth reckons upon coming here four hundred times to hear the remainder of the papers on the other sheets of the survey, but I fear I cannot undertake to attend on all these occasions. With respect to the meteorology there is little to say. Of course, this is, as Dr. Mill told us, only one four-hundredth part of the kingdom, and it is not very remarkable that there is not one complete station such as would be required to give details of temperature and pressure, but with very slight exceptions observations in the adjoining sheets would apply perfectly well. The difference between Bognor and Hastings is not probably greater than the difference between one part of the metropolis and another, and therefore complete stations are not required close together; but, in respect of rainfall, it is necessary to have the stations fairly close together. I should like to say it is no light undertaking to collect the statistics of the rainfall of the whole country; in the total it looks all very nice, but there is an enormous amount of work to be done. Before this is arrived at, for the United Kingdom, it would take a considerable number of clerks some years.

There are two small points in the paper I would like to mention, one with respect to the view of Bognor with the waves breaking on the rocks and shooting up higher than the houses. This reminded me of a story of my grandfather, who was at one time a great deal in that part of the country engaged in constructing those devices known as martello towers. He was building one near Bognor one day, when he saw a boat come in from Bognor rocks a little distance out, with a load of stones for building purposes. He said to the boatman, "Do you know what you are doing? You may depend upon it that Neptune will come along and fetch those rocks back again some day;" and I am inclined to think the old man was not so very far wrong. There is another point which is a mystery to me, and I am sorry Dr. Mill did not explain it; perhaps Sir Charles Wilson will do so. How did the Romans lay out these roads with such marvellous accuracy and absolute straightness, sometimes over 100 miles long?

Dr. Mill: There is little left for me to say, except to thank very heartily those who have spoken for the kindness of their remarks. I particularly appreciate the co-operation and sympathy of experts and specialists in the different sciences, but I am not going to allow that I have read a geological paper. It was a mere accident of the country that the dominating features happened to coincide with the geology; in another case the dominating feature might be the meteorology, in another simply the configuration of the ground. We could have a perfectly complete and purely geographical paper, descriptive of a region that lay entirely on one geological formation, and it would not matter whether it happened to be granite or slate. Then, again, this paper did not give a fair example of what I hope will be one of the most important features of the survey, *i.e.* the natural resources of the country, because there are many districts with immense natural resources not yet fully investigated. I refer more particularly to the great reserve of water-power in uninhabited parts of the country; all these will one day become of great value. Colonel Johnston said that treatment of this sort would help people in the country to understand what the survey maps can do. I remember the first interview I had

with a native upon these hills; he was a shepherd, and evidently a pure Saxon, for his "yes" was a "ja" as perfect as any I have heard in Germany. I showed him the 1-inch map, and though he had never seen a map before save in school, in five minutes he had fairly grasped the whole thing, but the application he made was a little surprising. "I have often seen people on bicycles with these maps; they ask the way, then look at the map and go the right way; you can never tell a man the wrong way with a map like that." That episode gave a little insight into what we may perhaps call the "slimness" of the Sussex peasant.

Sir CHARLES WILSON: I hope you will allow me to convey to Dr. Mill your very warm thanks for the paper that he has been kind enough to give us. I think it is one of the most suggestive and valuable that I have heard for a long time in this room, and the manner in which it has been delivered must have been agreeable to all of you. I think that Prof. Lapworth is rather inclined to lay upon Dr. Mill too heavy a burden. I am afraid if he were to attempt the 400 memoirs to the 400 sheets of the Survey, he would have more than his work cut out for him for his natural life. I hope and believe, however, that this scheme will go on, that Dr. Mill will be able to undertake some of the memoirs, and that we shall be fortunate enough to obtain the co-operation of other gentlemen who will write memoirs for the sheets in the admirable way in which Dr. Mill has treated this one. I have read the memoir in its written form, and I can assure you that you will find it extremely interesting; you will miss the excellent delivery, but there is much of interest which Dr. Mill has not had time to touch upon this evening. I hope many of his admirable illustrations will be published with the paper. In many ways the sheets selected for the specimen memoir are interesting; but I need not point out to you that there are equally, if not more interesting, sheets of which memoirs might be written—for instance, those which cover the development of parishes in a district originally covered with forest.

I hope you will allow me to return Dr. Mill a very cordial vote of thanks for his labours and the interesting way in which he has communicated them to us.

NEW LIGHT ON SOME MEDIÆVAL MAPS.

By C. RAYMOND BEAZLEY, M.A.

III.

IN this paper we are concerned with various inter-connected groups of mediæval maps, which have hitherto suffered from undeserved neglect even more than those of the Beatus family, but are certainly not surpassed in interest by the latter. For nowhere do we find the survival of ancient geographical ideas in the mediæval time more strikingly than in the allied designs of Lambert of St. Omer, the Macrobius and Sallust map-illustrations, and the "Climate" and T-O sketches.

I. Lambert, Canon of St. Omer, was the compiler of an encyclopædia, called *Liber Floridus*, composed of extracts from 192 different works. In this he has left us a chronicle which reaches down to A.D. 1119, and must have been finished before 1125. This chronicle contains, moreover, various maps, including a mappemonde, which has survived in

three different forms—to name only the principal—in the manuscripts of Ghent, Wolfenbüttel, and Paris.*

That of Ghent seems to have been written by Lambert himself; but it only gives us Europe, among the three continents of the world's scheme. The lesser map-sketches include a chart of the winds, one of the chief towns of the Oikoumenê, two Macrobian zone-maps, four astrological schemes, and a T-O map. The intention is clearly expressed (but not realized) of supplying a complete mappemonde, to remedy the deficiencies noticed above in the world-map.

The Wolfenbüttel manuscript is closely related to the Paris example: both are probably copies from the same original, and may be dated about A.D. 1150. In both, moreover, the mappemonde is complete (although the Europe of these designs is less detailed than in "Ghent"), and both possess a feature of peculiar interest. Nowhere else in mediæval cartography do we find a greater prominence given to the Unknown Southern Continent, the Australian land of the "fabled Antipods," than in the Wolfenbüttel and Paris redactions of Lambert's mappemonde. The Paris map is, however, much more imperfect than the other copies. All names of seas are wanting, the Mediterranean appears no broader than a river, and there is a want of all clear distinction between the various continents and countries. Here, too, the writing is exceedingly difficult; and Lambert's material has been greatly altered from the stage we find in the Ghent copy.

On these maps the seas and rivers are usually green, the mountains red. Each of the three copies has peculiarities of its own; thus, while Wolfenbüttel and Paris both give the Southern Continent beyond the equator, Paris alone contains the inscription explaining the same, and throwing so much light on mediæval ideas of the world. These ideas, as here expressed, are in close agreement with, and are obviously derived from, certain views of ancient Greek geographers, especially Krates of Mallos. According to this theory, the Oikoumenê, formed in the shape of an ellipse, was only one of four earth-masses, or quarters, which lay as it were like small islands in the vaster expanse of an ocean encircling all and dividing the various lands from one another. Of these four lands, the first, of course, was our Habitable World, the *terra cognita* of Europe, Asia, and Africa. The second was the southern continent just referred to, south of the equator, and separated from Africa (as then conceived) by a torrid strait of sea. The other two were on the reverse side of the earth-globe, and corresponded in some respects with the North and South America of later discoveries.

* The Ghent MS. is in the University Library, once in Library of St. Bavon, see fols. 28 and 241; the other two MSS. are numbered respectively Wolfenbüttel, 1 Gudiana Lat.; Paris, Bib. Nat., Suppl. lat. 10 bis. On Lambert's map Konrad Miller is especially admirable.

These land masses were divided by a tropical arm of ocean, in just the same way as the first two. Among these four earth-islands, Lambert clearly delineates the two on our side; while he suggests the third, and perhaps also the fourth (on the other side) by the little circles placed in the margin of the Oikoumenê, or Roman world, at the extreme east and west. These circles are referred by the draughtsman to Paradise and "our Antipodes" respectively; and here the latter term is

A T-O MAP.

(Sallust type, Leipzig, Eleventh Century, City Library, No. xl.)

clearly used, not in the ordinary and more restricted sense, but in a scientific manner. The "land of our antipodes" is to be understood as the continental mass exactly opposite to Europe, on the other side of the globe; and the Paradise-Island is also (probably) to be interpreted as precisely antipodean to the southern continent of our hemisphere. It is possible that the expression of this theory in Lambert's map was derived immediately from Macrobius or Martianus Capella; in any case it was widely diffused in the later imperial time, and its

occurrence here is another proof of the close dependence of mediæval geography upon classical antecedents.

The exact language of our present examples must be noticed. First, in the Terrestrial Paradise, we have the customary sources of the four sacred rivers, the Tigris, Euphrates, Gihon, and Pison. Like Kosmas, "the Indian traveller," Lambert evidently intends these rivers to have a subterranean course between Paradise and our World; but there is no indication in Kosmas of the fourfold scheme, or even of the Southern continent, partially reproduced by Lambert. Secondly, as to "our antipodes," marked by the little circle to the west of Europe, Lambert expressly declares this land to be inhabited by living, though not necessarily human, beings; and assures us that these beings have their day and night in an opposite relation to ours. Thirdly, as to the Southern, Australian, or trans-equatorial land of our hemisphere, below Africa, Lambert defines it as "A region of the south, temperate in climate, but unknown to the Sons of Adam, having nothing which belongs to our race." The equatorial sea* which here divided the land masses was not visible, he adds, to human eye, since it was always heated by the full strength of the sun, which prevented any approach of mankind, and allowed not of any passage across to this southern zone. But herein, proceeds Lambert, "as some philosophers believe, there is a race of antipods who are quite different beings from ourselves through the difference of regions and climates. For when we are scorched with heat, they are chilled with cold; and, whereas we are allowed to discern the northern stars, this is entirely denied to them. Days and nights they have of one length; but the haste of the sun in the ending of the winter solstice causes them to suffer winter twice over."

To the south of this temperate Australia, Lambert adds, with a true understanding of the climatic gradations of our World, was a zone of extreme cold, uninhabitable by living creatures.

The crooked line, running over the Equator, and marked by three star pictures, probably indicates the ecliptic or apparent path of the sun, whose obliquity is clearly suggested; just as the traditional T-O form of "Our World," the Northern or Roman Oikoumenê, is plainly indicated.

From all this it will be expected, as a matter of course, that the content and detail of Lambert's map, like his general conception, will be markedly antique in character, and this expectation does not mislead us. Though elsewhere realized to a greater or less extent, the relationship between the latter classical cartography and that of the middle ages is seldom to be found in such complete expression as in the case of Lambert. Of the one hundred and eighty legends in this

* "Mediterraneum mare."

map a great number are entirely ancient; the modern names are few, such as Norway, Flanders, Bavaria, and some others; even with Isidore there are not many points of agreement; and the connection with Orosius and Julius Honorius is not much more definite. With the Anonymous Geographer of Ravenna, there are, on the other hand, some surprising points of contact; the relationship, as far as names go, with Martianus Capella, with Solinus, with Beatus, with Aethicus of Istria, or with the Aethican Recension of Julius Honorius does not extend beyond a few

THE WORLD MAP OF LAMBERT OF ST. OMER.

small and sometimes doubtful points. Even with the Bible there are not many links; among the chief of these is the mention of Enoch and Elias in Paradise, a feature found nowhere else in mediæval maps.

The fact thus remains, that the detail, as well as the ground-plan, of Lambert's mappemonde is not to be found in earlier works of mediæval character, and must be referred for the most part to a lost design of the ancient world. The chief additions to this pre-mediæval work are made

by Lambert himself, and refer to the geography of his own time. We must not suppose that the present example is a compilation from the writings of a large number of authors. Plenty are named in the *Liber Floridus*, but they are only used in the way of extract, and do not much affect Lambert's map, except, for instance, in the natural history details, which he has there inserted,—such as the fauns of India, the apes of Partha, and the parrots and elephants of Arabia, to which, by a strange omission, he has not added the snakes of Ireland. Lambert's "Hyrcanian tigers" are perhaps from Ammianus Marcellinus; his "Arabian lions" from Strabo; his "Indian pygmies" from Isidore; his "trees of the Sun and Moon" from the Alexander Romance of the Pseudo-Kallisthenes; while his "Griffins of the North" might be derived from many authors. But there is no evidence, either in the text or in the map of Lambert, that he had any deep or thorough knowledge of the ancient writers whom he names, and from whom some have supposed that he derived his geography. The geography in question, on the contrary, was probably taken almost bodily from a map-design, closely similar to that used or designed by Macrobius.

II. The connection between the map of Lambert of St. Omer and the writings of Macrobius extends also to the zone- or climate-maps, of which one group is often known as "Macrobius designs." From Lambert's picture of the Oikoumenê, it is also clear that the so-called T-O maps are not unrelated to his work. Among the climate-maps (which all illustrate the various, usually five, zones or belts or chief climatic areas of the world) there are, as we have said, a number which add to this a special reference to certain passages in Macrobius. Ambrosius Aurelius Macrobius, who filled high offices of state under the Emperor Honorius, was probably a Greek by birth, and a pagan by religion. In his famous commentary on the Ciceronian Dream of Scipio, he discussed (at the fifth chapter of the second book) the question of the terrestrial zones; and to this passage the Macrobian sketches chiefly refer. They also draw some of their material from certain paragraphs at the end of the first book of the same commentary, where Macrobius deals with the attraction of the earth, and the question of antipodes; and from the seventh chapter of the second book, where the celestial zones and the currents of the ocean are explained. Macrobius shares with Sallust the peculiarity of special map-illustration, arising out of specific passages in the works of each; but whereas the Sallust maps stand comparatively apart, these Macrobian sketches, as we have seen, are clearly members of a large and interesting family.

Among the sketches in question, some give us nothing but the five zones; others picture the two earth islands of the eastern hemisphere, which we have noticed in Lambert of St. Omer. Here the encircling and dividing ocean, as in the maps of the 'Liber Floridus,' covers most of the Earth's surface; and the land masses are reduced, in Cicero's

words, to the position of "specks" upon the water. Here, moreover, the ocean currents, from the equator to the poles, are clearly indicated, and apparently conceived as the principal cause of the tides.

It is doubtful whether the Macrobius plans were soon altered by mediæval copyists to the uncertain orientation which we find in the manuscripts. But there is no doubt that Macrobius himself put the north at the top, for in the fifth chapter of the second book he says expressly that the *upper* temperate zone is inhabited by men of our race. In one of the zone maps here referred to, a distinction is also drawn between the domesticated folk of this same temperate zone and the wild men of the woods who inhabited arctic and torrid lands.

We have already alluded to the fact that in the 'Liber Floridus' of Lambert of St. Omer there are, besides the mappemonde, various Macrobian designs; and indications of the same character, written or sketched, may be found in many other mediæval authors. Thus, the venerable Bede, in his 'De temporum ratione,' discusses the five zones; and this work is accompanied by a Macrobian map, which is perhaps from the pen of the famous Northumbrian scholar of the eighth century. On this map the equinoctial belt is described, and the four great segments of the Earth's circuit are defined, in strict agreement with the original Macrobian language. Again, Honorius of Autun, in his 'Imago Mundi' (of the early twelfth century), reproduces Macrobian ideas, as Bede did before him, both in his text and in an illustrative sketch-map. Once more, William of Conches (de Conchis), who taught at Paris in the middle of the twelfth century, wrote a work on the 'Philosophy of Nature,' which contains three Macrobian maps. One of these merely sketches the five zones and the zodiac; another shows the two earth islands of the eastern hemisphere, as in Lambert; the third is more like a simple T-O design. Each of these has a different orientation. Yet again, the Abbess Herrade of Landsberg, in her 'Garden of Delights' (of about 1180), gives us a slight zone map with the ecliptic, after the manner of Macrobius; while another of the same kind is to be found in the 'De sphæra Mundi' of John Halifax of Holywood, in Yorkshire, the celebrated "Sacrobosco," who flourished and wrote in Paris about 1220. Lastly, we may notice in certain manuscripts of Hyginus, one of which is perhaps of the sixth century, a zone map which depicts the four land masses, not merely in Macrobian, but in full Kratesian fashion.

III. The remaining climate-maps are not always easy to distinguish, except by the absence of definite Macrobian reference, and the addition of non-Macrobian matter, from the zone schemes just noticed. But the sketch of Petrus Alfonsus of Huesca (of about 1100) is obviously designed with the special purpose of illustrating the Arabic conception of the world-centre called "Arym." This was sometimes viewed as a mathematical centre-point for the Oikoumenê, or in a wider sense for

the whole earth-circle or eastern hemisphere; sometimes as a home of accursed spirits; and sometimes as a mysterious and lonely mountain in the midst of the Indian ocean. In the eleventh-century writings of Gerard of Cremona, if not earlier, it passes into Latin thought; it is very prominent in Roger Bacon; and here in Petrus Alfonsus and other examples of mediæval cartography it is adopted as a geographical axiom of equal importance with the chief climates and celestial directions.

Undoubtedly these climate maps, both Macrobian and non-Macrobian, had their origin in Greek speculation and science. The type represented by them was a favourite with the Arabs; thus Masudi tells us he had often examined such works, and among them he distinguished those of Marinus of Tyre as the best. The genesis of the climate schemes was apparently as follows. *Klima* meant first the supposed slope of the earth from a higher north to a lower south, or *vice versâ*. Secondly, Hipparchus the astronomer, about B.C. 160, gave to the term the special meaning of different belts, or zones, of the curved or spherical earth surface, as determined by the different lengths of the longest day at Syene, Alexandria, Constantinople, and so forth. Thirdly, this conception passed into ancient cartography, and was embodied with an immense body of other matter on the maps of Ptolemy, and the "scientific" school. Lastly, the climate scheme was abstracted, so to say, from all else, and sketched in rough outline maps intended for the use of beginners. It is the works of this latter class which concern us here.

IV. The map of Lambert of St. Omer connects us not only with the Macrobius maps and the climate designs, but also with that curious variety of mediæval cartography known as the T-O schemes. These are very numerous, though at the same time very similar in character; at least eighty manuscripts, reaching from the eighth to the fifteenth centuries, contain designs of this type; and the conception of one and all is fully expressed in the lines of Dati—

> "Un T dentro a un O mostra il disegno
> Como in *tre parte* fu diviso il mondo."

In some of the earliest examples, however, the T and O formations are not combined; thus, in the oldest Isidorian analogues, we have the T formation associated with square and oblong, as well as with round, *enceintes*.

As early as the fifth century before Christ, some of the Ionic philosophers hit upon this as a convenient form for indicating roughly the chief divisions of the habitable world; and, in spite of Aristotle's contempt, it survived as a popular favourite. For along with the more scientific geography of the ancient world, there was also a popular system represented in some of its phases by the zone or climate sketches, and the fourfold Kratesian schemes we have already referred to; another side of the same comes out in the T or T-O designs. In the

execution of these, Greece was placed by some in the middle of the Oikoumenê, and Delphi, or Delos, in the middle of Greece. But whatever the differences of detail, the T or T-O maps were always meant as simple pictures of the grouping of the great land masses of the known world; and were usually associated with the allied conception of a centre for the "circuit of the earth," the infinitely extended horizon. Thus they did not necessarily deny the theory of a globular earth; but they were concerned, and only concerned, with its aspect as a surface, flat or slightly curved, as apparent to the ordinary observer. The execution of the T plan was by no means uniform; some making Europe, some Asia, the largest of the continents,* though no one gave the predominance to Africa, then usually believed to end in its southward direction on this side of the equator.

The "threefold division" (*trifaria orbis divisio*) of certain early geographers is probably expressed in some of the Sallust maps better than in the T-O plans of the usual type, and was less rigidly symmetrical and more reconcilable with scientific views. Here we have a threefold division of the Oikoumenê into fairly equal continents of Europe, Asia, and Africa; but in this type Asia has a certain though slight preponderance, the T has lost its rigidity, the idea of a central point is not expressed, and the general conception seems rather to rest upon the great fact of three land masses, than upon any exact tripartite division of the same. In some of the T-O family, we may also perhaps see traces of the three-cornered world pictures, or descriptions, which according to Orosius and others, were in favour in ancient schools, and were used along with fourfold or quadripartite presentations, based upon the four great quarters of the heavens and the four chief winds, to convey rough ideas of geography to learners. A clear description of a T map is given by St. Augustine, who must certainly have seen, and probably used, a work of this kind; and that at a time when scholars, politicians, and men of affairs were provided with representations of a wholly different character, resembling the type of road-map in ribbon form which has come down to us in the Peutinger Table.

The more important of the T and T-O maps which have survived are the following: Two in the works of St. Isidore; one of the ninth century (now at Madrid); the similar Strassburg map of the same age; the St. Omer design of about 1010; the plans in Lambert; one in the eleventh-century chronicle of the Six Ages of the World, by Hermannus Contractus; and, most elaborate of all, the Byzantine Oxford Example of 1110.† Besides these, there are many others, eleven of which occur

* Thus Pliny, out of sixty parts, gives Europe twenty-eight, Asia nineteen, and Africa thirteen. Orosius refers to a reckoning which made Europe exactly equal to the other two continents, while he also notes the views of others, which made Asia equal to Europe and Africa together.

† St. John's College Library, Cod. membr. fol. xvii., fol. 6.

in Isidore alone, but we need not do more than add a word about some of the chief examples already mentioned. Among these the two main Isidorian designs are found in the treatise of that Father, commonly known as the 'Etymologies' or 'Origins' (xiv. 2, 3). These are, perhaps, the best examples of the family as a whole, and are often spoken of as archetypal. Here, beside the three continents, we have the names of the three sons of Noah, one for each continent. Hence these are also called Noachic maps. The east is at the top, and the "Great" or Mediterranean sea occupies the whole of the T-formed intersection of the continents. Other schemes of this kind develop the simple titles (*Asia*, *Shem*, and so forth) by explanatory inscriptions, which declare, for instance, that Asia has its name from a Queen Asia, and is inhabited by twenty-seven peoples; that Africa is derived from Afer, a descendant of Abraham, and has thirty races with 360 cities; and that Europe, named after the Europa of mythology, is overspread by the fifteen tribes of the sons of Japheth, who possess 120 cities.

The Strassburg plan, of about 870, attempts rather more of detail, giving us, in Europe, the names of Greece, Italy, Frisia, and four divisions of Germany; the Amazons, India, and some scriptural names in Asia; Carthage and some other places or regions in Africa. Jerusalem is marked by a Greek cross, but not in the centre of the circle.

The St. Omer sketch of 1010 accompanies a collection of Homilies, and gives us the newer names of England and Hibernia, Thule, and Scandinavia; but the so-called "Oxford" of 1110 is fuller still. In many ways this is the leading example of the T-O family. Of course we must not here expect anything more than a simple and slight presentation of Earth-knowledge; its content is mainly Biblical, but it contains some features suggesting a high antiquity (such as the inclusion of Africa under Europe) and other clear marks of Greek or Byzantine origin. Thus, the four quarters of the heaven have the Greek titles of Anatolê, Disis (δύσις), etc., combined with Latin equivalents, Oriens, Occidens, and so forth. Here also is one of the first examples where Jerusalem appears with the cross and the hill of Zion as the centre of the Earth. The beginnings, moreover, of some other favourite mediæval traditions are roughly sketched—such as the 72 races of greater Asia, the 27 tribes of Shem, the 15 of Japheth, the 30 of Ham, the 33 of Armenia, as well as the 12 tribes of Israel, and the *Divisio Apostolorum*. We are not surprised to find an utter misplacement of many of the chief names; thus Constantinople is in Asia Minor, Armenia in the south of Asia, Palestine and Judæa in adjoining plots of what is labelled "Europe," but which, as far as the drawing goes, belong to Africa. The 72* races of Great Asia are based perhaps on

* Cf. Gervase of Tilbury, 'Otia Imperialia,' ii. 1.

the 70 of the Mosaic table, and the whole design may be fairly ascribed to a copy of a Byzantine work brought home by the first Crusaders.

V. Many of the Sallust maps conform in every respect to the T-O model, and may be considered a variety of the latter, but with the addition of distinct reference to the 17th, 18th, and 19th chapters of the 'Jugurtha;' just as the Macrobian section of the climate-maps makes reference to certain passages in the first and second books of the 'Commentary on the Dream of Scipio.' The Sallust examples are also, as already suggested, rather less symmetrical and conventional than the ordinary specimens of T-O cartography. The relationship of this group of designs was first noticed by Spohn and Wuttke; Lelewel, Philippi, and Konrad Miller have greatly developed the study of the same; but it is probably capable of still further expansion. As yet we know of eight larger and five smaller Sallust maps; of these the earliest and three of the most important are now at Leipzig; one other at Görlitz is of special interest. The oldest example, of about A.D. 980, occurs in a fragment of a Catilina manuscript, once used for book-binding. It is faded and obscure, but the traces of a city picture of Rome, some smaller sketches, and various names are still discernible. This map conforms to the regular T-O type, employing the Mediterranean, Tanais, and Nile in the usual manner to divide the three continents. Another Sallust design of the eleventh century, also at Leipzig,* is the most elaborate of this family, giving us pictures of Rome, Troy, Babylon, Carthage, Cyrene, and Jerusalem; together with indications of the Nile, Danube, Tanais, and Rhine, among rivers; and of the Alps, Lebanon, the Riphæan hills, Mount Atlas, and the Pyrenees among mountains. In the general design a rather free handling of the T-O conception is adopted, as in the Görlitz of the twelfth century, which is one of the best and least conventional specimens of this type, but marred by an inclination to centralize Jerusalem, more pronounced than in the earlier members of this group. In another tenth-century Sallust design, otherwise of no interest, we have the characteristic note, "Julius the Emperor divided the whole world into its several parts."

It was probably at an early date, long anterior to our oldest surviving Sallust *manuscript*, that the normal Sallust *map* was inserted to illustrate the 17th chapter of the 'Jugurtha.' This special plan, adapted to a particular text, was however replaced in most manuscripts by a simple T-O sketch, lacking all definite reference to Sallust materials. The oldest example shows us, perhaps, the original type, a pre-Christian map without Jerusalem and with an overshadowing Rome. From this point of view we shall be led to push the archetype further back than Wuttke,

* In a manuscript containing Lucan and Capella as well as Sallust.

who is satisfied with the authorship of a priest in the north of Italy, between A.D. 600 and 700. According to Konrad Miller's view, the two oldest Leipzig copies, including the show specimen of about 1060, already noticed, belong to one family; the Görlitz and thirteenth-century Leipzig to another. He would maintain, and no doubt rightly, the separate existence of both these families as early as about 850; and the common original may fairly be referred to a time before the destruction, if not before the conversion, of the Roman Empire in the West.

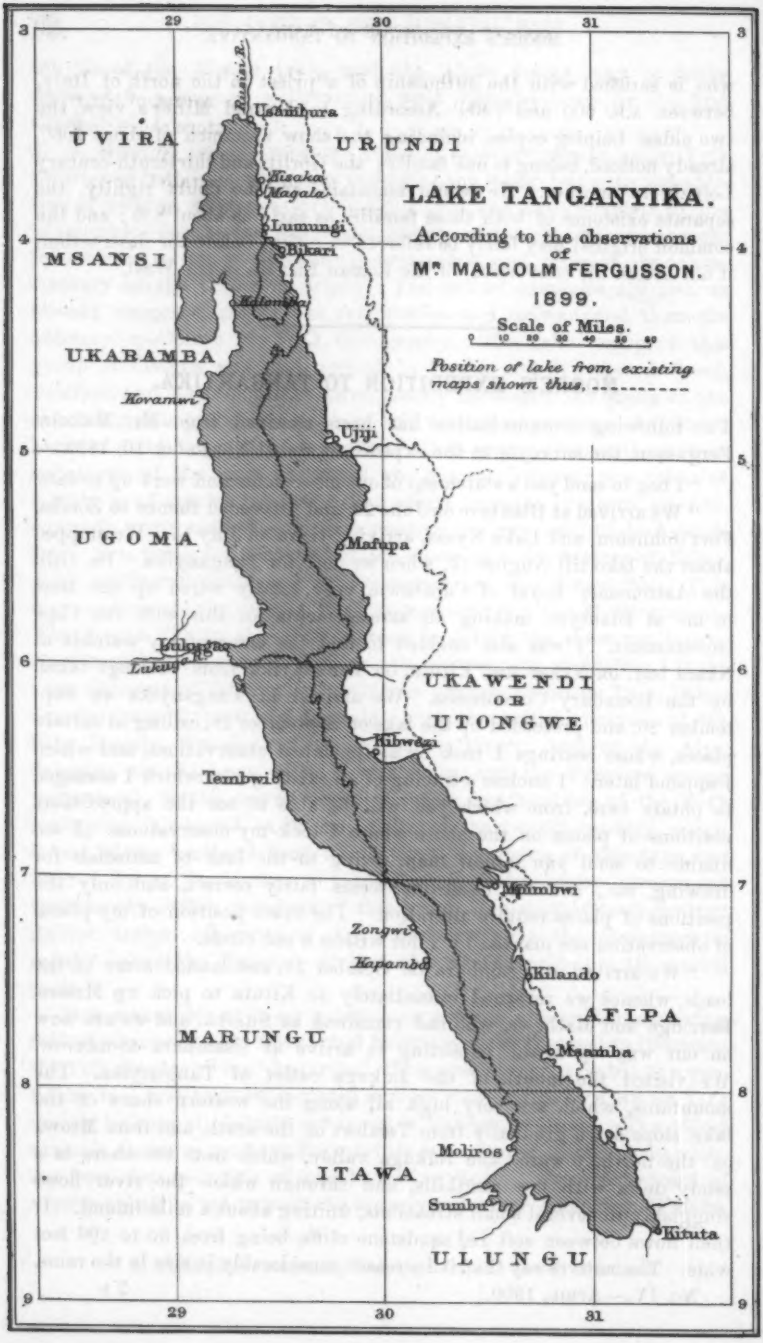
MOORE'S EXPEDITION TO TANGANYIKA.

THE following communication has been received from Mr. Malcolm Fergusson, the surveyor to the expedition, dated November 10, 1899:—

"I beg to send you a statement of our movements and work up to date.

"We arrived at Blantyre on June 28, and proceeded thence to Zomba, Fort Johnston, and Lake Nyasa, arriving there on July 11. We stopped about the lake till August 15, when we left for Tanganyika. Dr. Gill, the Astronomer Royal of Capetown, very kindly wired up the time to me at Blantyre, making all arrangements for this with the Cape Government. I was also enabled to find the error of my watches at Nkata bay, on Nyasa, and Kituta, on Tanganyika, from bearings taken by the Boundary Commission. We arrived at Tanganyika on September 20, and proceeded up the lake on September 28, calling at certain places, whose bearings I took by astronomical observations, and which I append later. I enclose a tracing of an existing map which I managed to obtain here, from which you will be able to see the approximate positions of places on the shore where I took my observations. I am unable to send you a new map, owing to the lack of materials for drawing, etc., but the coast-line seems fairly correct, and only the positions of places require alteration. The exact position of my places of observation are marked by a dot within a red circle.

"We arrived at Usambura on October 21, and landed some of the loads, whence we returned immediately to Kituta to pick up Messrs. Berridge and Mathews, who had remained at Sumbu, and we are now on our way up again, expecting to arrive at Usambura to-morrow. We visited the mouth of the Lukuga outlet of Tanganyika. The mountains, which are very high all along the western shore of the lake, slope down gradually from Tembwi on the south, and from Mtowa on the north, towards the Lukuga valley, which near the shore is a sandy delta with low sandhills, and through which the river flows sluggishly in several small streamlets, uniting about a mile inland. It then flows between soft red sandstone cliffs, being from 50 to 100 feet wide. The natives say that it increases considerably in size in the rains.


LAKE TANGANYIKA.
According to the observations of
Mr MALCOLM FERGUSSON.
1899.
Scale of Miles.
0 10 20 30 40 50
Position of lake from existing maps shown thus, ----------
UVIRA
URUNDI
MSANSI
UKABAMBA
UGOMA
UKAWENDI OR UTONGWE
MARUNGU
AFIPA
ITAWA
ULUNGU
Rusizi R.
Usumbura
Bisaka
Magala
Lumungi
Bikari
Kalambo
Kovamwi
Ujiji
Mafupa
Lukuga R.
Kibwesi
Tembwi
Mpimbwi
Zongwe
Kapamba
Kilando
Msamba
Moliros
Sumbu
Kituta
29
30
31
3
4
5
6
7
8
9

Far back from the lake, perhaps 15 miles, the high mountains can be seen to continue, with a gap, which is evidently the course of the river.

"The mountains, which are high all along the western shore, increase very considerably at the north-west, by Uvira, attaining an altitude of, I should imagine, about 8000 feet. They form a parallel range with the mountains on the north-east shore, which are also of considerable height. The Rusisi valley lies between these ranges, which continue away beyond the northern shore of Tanganyika.

"Usambura, where we finally land, is a German station on the northern shore of the lake, being about 6 miles south-east from the Rusisi mouth. The Germans have also formed stations on the Rusisi river, and two at Lake Kivu.

"We expect to leave Usambura within a week, and proceed thence to Kivu."

Bearings of Places on Lake Tanganyika.

Name of place.	Lat. S.	Long. E.
Sumbu	8° 32′ 20″	30° 30′ 15″
Moliro's	8° 16′ 14″	30° 36′ 15″
Msamba	7° 48′ 0″	30° 46′ 30″
Kilando	7° 27′ 18″	30° 40′ 15″
Kibwezi	—	29° 56′ 30″
Tembwi	6° 33′ 40″	29° 29′ 15″
Lukuga	5° 55′ 44″	29° 14′ 15″
Mafupa	5° 25′ 0″	29° 48′ 15″
Ujiji	4° 56′ 57″	29° 40′ 30″
Usambura	3° 24′ 0″	29° 22′ 30″
Lumungi	3° 56′ 14″	29° 25′ 30″

Note.—The hitherto adopted delineation of Lake Tanganyika, shown on the map by a dotted line, is that resulting from the careful compass survey of Mr. E. C. Hore, combined with the longitude of Ujiji, as fixed by Cameron from lunar observations (30° 4′ 30″ E.). By dead reckoning the latter obtained the longitude of 29° 59′ 30″ E., or slightly nearer the position as now fixed. Speke also placed Ujiji slightly west of 30°. Mr. Hore's observations for variation (by which the inclination of the axis of the lake was determined) gave the former as 11° W. at Ujiji and 14° W. at the south end of the lake, while Cameron seems to have taken the variation to be 17° W. throughout ('Across Africa,' ii. 303), thus obtaining a still greater inclination of the axis of the lake from the north and south line than is shown by Mr. Fergusson. His longitude for the north end was nearly accurate, but for the south end was 1° too far east. The German officer, Captain Ramsay, whose observations for latitude in the districts east of the lake have been published from time to time in the *Mitteilungen aus den Deutschen Schutzgebieten*, does not appear to have determined the longitude of Ujiji, but he obtained a value (20° 58′ 45″) for that of the mouth of the Rugufu, south of the Malagarazi, which agrees fairly well with Dr. Fergusson's results (*Mitteilungen*, etc., vol. x. p. 232).

THE RUINED CITIES OF CENTRAL AMERICA.—REVIEW.

By Colonel G. E. CHURCH.

UNDER the modest title, 'A Glimpse at Guatamala, and Some Notes on the Ancient Monuments of Central America,'* we have a beautifully and artistically illustrated quarto volume by Anne Cary Maudslay and Alfred Percival Maudslay. It is a book of travels and archæological research in that region of the New World, the ruined cities of which have so often challenged the scholar to read upon their extraordinary monuments something of the history of the strange effort at civilization which they indicate.

Leaving London, the travellers reached Guatamala city by the way of San Francisco and the Pacific coast, and at the beginning of January, 1894, had prepared their outfit of mules and attendants, and found themselves *en route* eastwards. The general description of the voyage appears to have been left to the pen of Mrs. Maudslay, and the ruined towns and cities to that of Mr. Maudslay. Judging from results, the work could not have been better apportioned, and we know not which to admire most. Mrs. Maudslay at once makes the reader one of the party. We accompany her along the road to Mixco, to Antigua and its attractive coffee-fields, ascend with her the volcano de Agua, visit the remarkable lake and volcano of Atitlan, wander into the quaint town of San Antonio, see the primitive school and its more primitive teachers, and the religious Indian ceremonies. We wind along the mule-tracks among old mounds, ruins, and ancient Indian strongholds; enjoy the views of lakes, rivers, hillsides and mountains, sunsets, clouds, and shadows, while strangely costumed men and women gaze upon us with wonderment. We revel in riotous tropical scenery and its surroundings, and, over all that we see, the writer has the rare gift of spreading the lazy, dreamy atmosphere of the country, while not neglecting to enrich her pages with valuable historical and other data. At Coban, Chichén, Ytza, and Palenque, we are entertained with the everyday life of the travellers in a way to make us feel that we have contributed to the success of the expedition. Here and there among the chapters of Mrs. Maudslay are found notes of an archæological character by Mr. Maudslay. A chapter by him on the Quichés and Cachiquels is of great interest, but we wish he had told us more of them and their barbaric civilization, which so nearly approached that of the Maya-Toltec and Aztec peoples. Mr. Maudslay vastly increases our knowledge of the ruined cities of Central America, and gives us a taste of what we may find in his forthcoming monumental work 'Biologia Centrali Americani.' Maps, views, plans of ancient edifices, temples, mural paintings of battle scenes, ancient strongholds, carved monuments,

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inscriptions of Maya hieroglyphics crowd the volume, and attest to the indefatigable, intelligent, and patient labours of the author, and how far he has left behind all previous explorers in his chosen field. After eight years of voyages and studies among these ruined cities, he is probably better equipped for controversy regarding their origin and that of the people who inhabited them than any other archæologist and traveller. He thinks it "probable that the Mayas and so-called Toltecs were originally the same people."

Sufficient evidence exists to warrant the assertion that the Nahuatls originally occupied British Columbia and the now Pacific coast states of the United States; and, as their territory failed to meet the increasing demand for food products, they pressed southward—horde following horde, at long intervals of time, into the rich and inviting valleys of Mexico. The Toltec branch appears to have been one of the first to reach the vicinity of the valley of Anahuac, and to commence the civilization of the district by building the city of Tollan at its northern entrance. Here are now found those ruins and monuments which are believed to be quite as remarkable, in an architectural sense, as those of Central America, and to give silent testimony that the Toltecs were the most skilful workers in stone, metal, and rude industrial arts of all the Nahuatl race, and that they reached a higher grade of barbaric civilization than any of the tribes which followed them from its northern hives. If, finding their position untenable, they migrated southward from Tollan, they probably sought that portion of the Mexican peninsula which they thought would afford the greatest security—the region where we now find the ruined Maya-Toltec cities described by Mr. Maudslay. Although Mexican tradition has it that their migration was voluntary, it may be possible that they were completely overthrown by the invasions of their Nahuatl kinsmen, and forcibly removed beyond the isthmus of Tehuantepec, to Yucutan and its vicinity, to become an outlying Mexican colony; as it is not natural for a highland people like the Toltecs to willingly migrate to a tropical, lowland country but little above sea-level.

Some hold that the Nahuatls never subjugated the region south of the isthmus of Tehuantepec; others, with considerable evidence, maintain that they had colonies even in Costa Rica; and Mr. Maudslay says that tribes of "distinctly Nahuatl origin are found in Nicaragua." We are inclined to the belief that the Mexicans pushed their conquests south-east nearly to the isthmus of Panama, spreading their language among the Indian tribes as they reduced them, and locally applying great numbers of Nahuatl names, notably those of numerous plants, animals, and geographical localities, which still remain. Their language was also sufficiently powerful and dominating to weave itself largely into the colonial Spanish of Mexico and Central America, and some traces of it are found even in South America.

In an illustrated and final chapter on hieroglyphic inscriptions, Mr Maudslay points out the considerable difference between Mexican picture-writing and Maya hieroglyphics, translates the month signs, numerals, signs denoting periods of time, great cycles, etc. What he has already accomplished leads us to hope that, ultimately, much of the mystery relating to the history of a lost and interesting race will be dispelled, and that a key will be given to us to unlock many of the ethnological secrets of the New World.

NARRATIVE OF A JOURNEY TO THE LAKES RAKAS-TAL AND MANASAROWAR, IN WESTERN TIBET, UNDERTAKEN IN SEPTEMBER, 1848.*

By Lieut.-General Sir RICHARD STRACHEY, R.E., G.C.S.I., F.R.S.

As we went along the edge of the lake we saw many water-birds; among them were ducks and gulls, and two species of heron, one large and grey, the other smaller and brown. The waves that roared as they rolled towards us, and, breaking in long lines of foam, receded over the shingly beach; the broad expanse of the sea-green water; the gulls riding on the swelling waves, or skimming over the white crests of the breakers; and the high fresh wind blowing across the lake, produced a series of impressions such as are so naturally associated with our ideas of the ocean, that it would have called for but little exercise of the fancy to carry us from the banks of this mere mountain lake to the stormy coasts of some northern sea. The great snowy masses of *Gurla* formed an appropriate background to the picture, while the peaks of the Nepal Himalaya stretched away in a long succession to the east as far as the eye could reach. Looking to the south, we saw a long narrow line of beach thrown up into several parallel mounds, running for some distance along the foot of the steep bank of the alluvial isthmus over which we had come. A projecting point cut off our view of the south-west corner of the lake. A Buddhist monastery, *Gusur*, stands there, but it was not visible. Our cavalcade at length came to a halt about 2 miles south of *Ju*, on a narrow flat strip of ground between the beach and a low line of cliffs which here flanked the lake; and, leaving the majority of the party behind to pitch the tents, etc., Mr. Winterbottom and I went on to examine the place where the stream that flows from *Manasarowar* leaves the lake. We passed some dry stone hovels, but they bore no signs of having been inhabited lately, and near the same spot we were shown some holes said to have been old gold-pits, now abandoned. These are alluded to by my brother, who, on his way round from the north shore of *Rakas-tal*, passed over the same ground as we had done from *Tung-kong* to this place. He mentions that the working of these pits was stopped in consequence of the ghostly advice of the monks in some of the neighbouring monasteries, and I was told that their objections were based on the fact of pieces of gold having been discovered having the forms of men, which was considered portentous to a high degree. It is worthy of note that the Tertiary alluvial deposits of Tibet generally are auriferous, though the quantity found in them has hitherto been very small. The gold seems to be found in the same manner as is usual in other alluvial deposits, in grains and nuggets of various sizes; and is therefore to be distinguished from the scales or spangles that are

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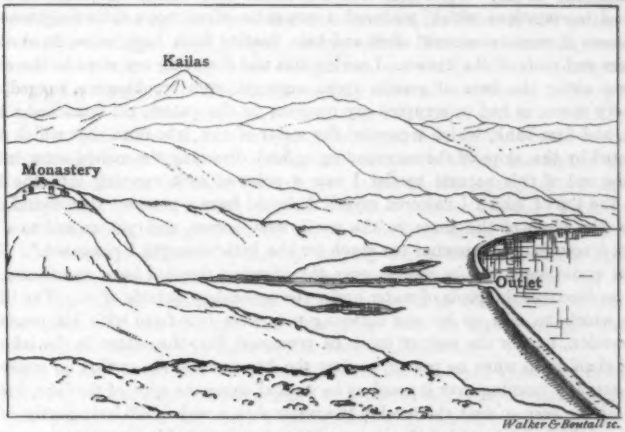
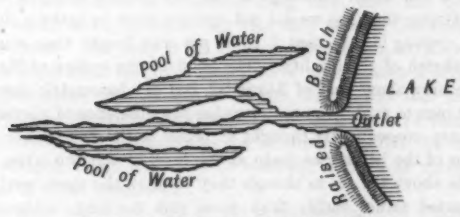
* Continued from p. 264. Map, p. 204.

frequently obtained from washing the sands of the Himalayan rivers. The Tibetan gold-pits are worked with shafts and galleries in the alluvium, and the remains of them are to be seen in many parts of the country. The working of the pits is a Government monopoly, and considering what a Tibetan Government is, and what Tibetan workmen are, the small amount of gold now produced is no proof that the alluvium of Tibet may not be rich in gold.

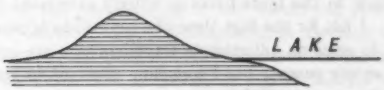
As we approached *Ju*, a steep rocky point rising abruptly from the lake forced us to ascend. From the height to which we climbed we looked down on the



SKETCH OF OUTLET FROM MANASAROWAR, SEEN FROM THE SOUTH.



PLAN OF OUTLET FROM MANASAROWAR.



SECTION OF RAISED BEACH.

stream that connects *Manasarowar* and *Rakas-tal*. The rocks on which we stood formed one flank of the ravine through which it flowed; on its opposite bank was the monastery of Ju, looking very mean, apparently a collection of ruined mud buildings on the top of a hill, with an inhabited portion somewhat lower down towards the lake, the whole oddly stuck about with poles, decked out with rags. The ground at the bottom of the ravine was quite flat, and about on a level with the surface of the lake. A raised beach, which swept in a well-rounded curve

along the edge of the lake, was cut through by the effluent stream. This was of no great breadth, and apparently shallow and connected with several pools of still water that looked like old channels. It is strange that Moorcroft, deliberately going to look for the point of efflux, should not have noticed it. His account is as follows: "As the bank approached this angle (*i.e.* the north-west angle of the lake) it declined to gentle elevations leading to interrupted tableland, and at its base was a large bay, from the bottom of which rose a pyramidal red rock, connected with a line of ridge of high land to the higher flats to the north, and steep towards the south. Upon this was the house of a *Lama* and many *Gelums*, pitched in situations which produced a romantic effect, not a little heightened by streamers of various-coloured cloth and hair, floating from high poles, fixed on the corners and roofs of the houses. Leaving this and diverting my steps to the south, I went along the base of granite rocks amongst such troublesome, rugged, and slippery stones as had interrupted my progress in the outset, till I reached a high, level, and firm bank, which separated the water of the lake from that which accumulated by the slope of the surrounding upland directing the melted snow into it. At the end of this natural barrier I saw a point of rock running into the lake, from the top of which I flattered myself I should have a prospect that would command the whole of the shore to the south-west corner, and put an end to a task which I now found somewhat too much for the little strength I possessed." From this it would seem that he passed over the identical beach I have mentioned, and that he describes the pools of water under the monastery outside of it. The illness from which he tells us he was suffering may have interfered with his powers of observation, but for the rest it must be presumed that the water in the lake was lower than usual when he passed, or that the bar was higher, so that no water was then actually running over it; and as he walked along the edge of the lake, his eye would have been so near the level of the water that a very small irregularity of the beach might have concealed the course of the stream from his view.

There were a few small buildings on the low ground near the lake, and men moving about among them, so we did not venture down to make a closer scrutiny; it was, besides, getting late, so that I could not wait longer than was necessary to make a slight sketch of the locality. The level of the surface of Manasarowar is, of course, something above that of Rákas-tal, but my barometric observations were not sufficiently nice to enable me to determine the difference of elevation with any certainty. I have consequently thought it better to throw together the whole of the observations of the barometer made at the level of the two lakes, and to calculate the altitude above the sea as though they were on the same level.

We had started rather earlier than usual this morning, without having any proper breakfast, intending to stop on the road for this meal; but we did not do so, and before I got back to the tents I was so utterly exhausted that I could hardly drag myself along. I felt for the first time the sensations of weariness and drowsiness that are said to seize on unfortunate travellers who are overcome by cold or fatigue in crossing snowy passes; but I somehow managed to get to the end of my walk. At 8 p.m., thermometer 31°·2.

September 17. *Manasarowar back to Rakas-tal*, 14 *miles.*—At 6 a.m., thermometer 23°; at 8 a.m., thermometer 34°·4. The north-west angle of *Manasarowar* having been the furthest point to which we thought it expedient to extend our journey, we to-day began to retrace our steps towards Milam. Several causes led us thus to conclude our expedition. The most important was the lateness of the season, for it would have been rash to delay our passage of the Indian watershed later than the beginning of October. The necessity for avoiding intercourse with the people of the country prevented our obtaining

fresh supplies of food, and the risk of detection increased as we increased our distance from home. But though it was prudent on the present occasion to return when we did, yet the population is so exceedingly scanty that an expedition might, I believe, successfully penetrate to a far greater distance into this part of Tibet without interruption, if properly organized.

While the tents were being packed up, we went on to the high ground over the spot where we had encamped, and from a slight eminence on its undulating surface we saw across from one lake to the other, and could trace the hollow through which the stream that connects them runs. The peak of *Kailas* stood out prominently among the mountains that flanked the lakes on the north. The greater part of these outer ridges, among which *Kailas* is situated, were not snowy; but a mass of very high mountains was visible to the north-west of *Kailas*, and a long way behind it, thoroughly covered with snow. The peak of *Kailas* rises from a transverse outlier of a range the axis of which is much further back. The peak forms a most conspicuous object from all the southern shore of *Rakas-tal*, and from this point of view the valleys by which the snowy mass of *Kailas* is cut off from the other prominent ranges to the right and left are very distinctly seen. I have already noticed a hollow that we crossed on our way to *Manasarowar*, terminating at a little bay about halfway down the west side of this lake, into which it drains. By way of varying our homeward route a little, we turned up this towards *Rakas-tal*, and we found that its watershed was almost close to the edge of *Rakas-tal*, and hardly so much as 100 feet above the level of the lakes. It was through this depression that we had seen the water of *Manasarowar* when we first came within view of *Rakas-tal*.

Early in the day we saw a fox; later another of the small antelopes and many hares, one of which, being foolish enough to squat within 8 or 10 yards of us, was cut nearly in two by a ball from a pistol carried by one of our people. A pack of donkeys, into the middle of which we walked when suddenly turning a corner, fared better, for no firearms were forthcoming until they had got safely away. It is, perhaps, worth while for me to say that this animal, the *kyang*, is a decided ass, and not a horse. Not only is his external appearance in all respects that of an ass, but his disposition also, of which I have myself seen sufficient proof, in a young animal obtained from people at Milam, which was sent to Calcutta, but died on its voyage to England. A distinction has been drawn, I think, between the markings of the skin of the *kyang* and the common ass; but the transverse stripe across the shoulders, which is said to be wanting, is often as strongly marked as in the donkeys of these mountains.

We struck upon *Rakas-tal* close to the commencement of a great raised beach that stretches along the south-eastern angle of the lake. It has a breadth of 200 or 300 yards from the present edge of the water, and seems to be composed entirely of granitoid detritus. Several interior lines, forming a series of steps or parallel roads, lie between the present high-water level of the lake and the uppermost of the beaches, which rose above all in a great mound of very remarkable height. These features were here most strikingly developed, a consequence, no doubt, of the violent south-westerly winds which blow so regularly in the afternoon, and constitute this a permanently dead lee shore. There is no evidence available to show whether there is any considerable variation in the level of these lakes from year to year, or from one season to another; but I think that such variations as must have taken place to explain the existence of some of these beaches are hardly compatible with existing conditions, and it is probable that these lakes have been gradually drying up, as seems to be the case in most of the lakes that have been observed in other parts of Western Tibet.

As we reached the border of the high land overlooking *Rakas-tal*, we saw not far before us a considerable party of travellers with horses, cattle, and sheep, and we halted a little to allow them to get ahead. The view of the snowy masses of *Gurla* across the bay was savage and grim. The wind had begun to blow with great force, and was gradually rising, and the whole surface of the lake was white with foam; but, as in the forenoon the direction of the wind is south-westerly, no waves now broke upon the shore on which we were.

In our progress along the beach we came to a place in which the surface had been levelled, and a rough pavement had been made with the rounded stones, divided into several compartments, some of which seemed to have served as floors for tents, others to have formed small open courts. We were informed that it was the spot where a Tibetan grandee from *Lhasa* had encamped not long before. He was, I think, the officer called *Zhipchet*, a sort of special commissioner, and had been into *Purang* on some public business.

As we reached the corner at *Lagan Tunkong*, we saw that some of the party of Tibetans had pitched a tent near the ruined *Dharmsala*, but the wind now was blowing so furiously that no one would remain exposed to it who could possibly find shelter, and accordingly not a soul was to be seen outside the tent, close under which we passed. As a precautionary measure, and to find out the news, our two headmen, *Bachu* and *Boru*, went into the tent to pay the Huniya traveller a visit. He turned out to be a landholder of *Purang*, and had some slight previous acquaintance with *Boru*. His teapot being already on the fire, they were all soon tea-drinking and gossiping, and the Tibetan squire was amused with the commencement of a mock bargain for sheep and wool, which was to be pursued further the following day on the road to *Purang*. Their worthy host must have been a little puzzled the next morning to find that his Bhotiya customers had altogether vanished. Another division of the Tibetan travellers had selected a more sheltered place for their camp a little further on; they turned out to be servants of the Tibetan abbot of *Darchin*, a monastery at the foot of *Kailas*, to the north of *Rakas-tal*, who had been sent to look after the getting in of the crops on certain lands in *Purang* belonging to his convent. There was no suspicion afloat in either quarters of the intrusion of a "Feling," as the Tibetans term all Europeans, making a further change from the name "Feringi," the usual Asiatic corruption of the word Frank. Our Bhotiyas had accordingly become mightily courageous.

We halted about half a mile beyond the ecclesiastics in a retired little bay on the edge of *Rakas-tal*, not far from where we had stopped on our outward journey. There was here again one of those raised beaches already so frequently seen, but of no great extent.

At 8 p.m., thermometer 30°·5. The vegetation along the southern shore of *Rakas-tal*, and between this lake and Manasarowar, was most scanty. The following will, I think, include most of the larger plants: *Caragana pygmæa*, *Potentilla sericea*, *Thylacosperma cæspitosa*, *Silene Moorcroftiana*, *Dracocephalum heterophyllum*, *Nepeta Tibetica* and *supina*, *Oxytropis Stracheyana*, *Aster molliusculus*, *Senecio coronopifolius*, *Artemisia Stracheyi*, a *Tanacetum*, *Lactuca Lessertiana*, *Androsace villosa*, *Sedum fastigiatum*, *Draba lasiophylla*, *Delphinium cæruleum*, and *Allium Jacquemontii*. The addition of a few grasses and cyperaceæ to the above list would nearly complete the enumeration of the flora of this desert region.

September 18. *Along the South Shore of Rakas-tal to the Camp of September* 14, 10 *miles*.—At 6 a.m., thermometer 22°·8; at 8 a.m., 34°. The first part of our journey to-day lay over the ground we had passed before, but ultimately we kept rather more away from the lake, following a more direct

course, and at times approaching the watershed between the lake and the *Karnali* river. It was during this day's journey, I think, that we had the finest views of *Rakas-tal*, its long islands and deeply indented bays, varying in apparent form with every change of position, while the eye never wearied in gazing on the heavenly blue of the water, or on the magnificent snowy dome of *Kailas*, which so conspicuously crowned the rich purples of the distant mountains. In crossing some of the ridges on our way, we looked down into the upper part of the valley of the *Karnali*, and the positions of some of the chief places were pointed out to us. This appears to be in every respect a normal Tibetan valley. It is flanked on either side by the remains of alluvial deposits, the flat tops of which are very far raised above the existing river-bed, and are manifestly nearly on a level with the general surface of the great plain of *Guge*. It is difficult not to conclude that the lower part of the hollow now forming the valley of the *Karnali* must at one time have been entirely filled up with deposits, continuous with those of the great plateau, and caused by the same agencies, and that the deep channel in which the *Karnali* now flows was subsequently cut out by the river, after some great change had taken place in the conditions of the surface and the arrangements of the drainage. The mountains of the Indian watershed along the frontier of *Byans* and the north-western angle of *Nepal* looked very fine, thickly set with snowy peaks. We now, too, obtained an instructive view of *Gurla*, which was seen to be composed of a series of masses of mountain, their north-eastern ends being precipitous, and their southern faces dipping at rather high angles to the south-west towards the Himalaya. From what I saw of the rocks myself, and from my brother's accounts, it appears certain that *Gurla*, like most of the highest peaks of these mountains, is chiefly made up of gneiss or mica schist, with a comparatively small quantity of granite. On our return to our old encamping-ground, we found that during our absence a party of Huniyas had passed along the road which I mentioned as having been seen a little below our camp, and they had been not a little alarmed at finding a party of men halting in so secluded a spot, thinking, with some degree of justice, that people who had no cause for concealment would not have selected such a place to stop at. They were, however, at last much comforted when they discovered that our men were peaceable Juhari Bhotiyas, and not the redoubtable *Kampa*. At 8 p.m., thermometer 30°·2.

September 19. *From Rakas-tal to the Valley of the Karnali, 7 miles.*—At 8 a.m., thermometer 33°. We now prepared to cross over the range separating *Rakas-tal* from the *Karnali* river, and accordingly set off straight up the ravine in which we had been encamped. To the summit of the watershed the hills were of the same eruptive rocks, with the same rounded forms and with the same miserably barren aspect, though bushes of diminutive growth succeeded in reaching the crest of the ridge, which we crossed at an elevation of about 16,850 feet. The small stream that gave life to a narrow fringe of verdure along the bottom of the ravine up which we came was now frozen into an almost solid mass by the severity of the night frosts, and at the head of the ravine lay a small patch of snow, the second, I think, that we had anywhere noticed since we crossed the *Baleh* pass. At 11 a.m., thermometer 46°·5, we crossed the ridge, and finally took leave of the lakes, not at all sorry to be once more fairly on our way out of this desolate country. A steep descent brought us very soon upon some less inhospitable-looking ground than we had seen for many days, where a Huniya tent was established. Keeping clear of this, we crossed some hills of no great elevation intersected by deep ravines with flat bottoms of cheerful green herbage and small clear streams full of small fish. The bushes and herbage seemed to show, by their luxuriant growth, that these retired valleys were but little frequented by the Tibetan shepherds.

Among these hills we once more got into stratified rocks, consisting of slates and limestones, in which no fossils could be seen, much shattered and contorted, but on the whole dipping to the north-west. We encamped in a sheltered ravine about a couple of miles from the *Karnali*, having made a short march in order to give the cattle a little rest, for their feet had suffered a good deal from their late constant marches over the sharp angular fragments of stone that everywhere cover the surface of this region of igneous rock.

The hills close along the south bank of the *Karnali* west of *Khardam* seem here generally to dip to the south, but they are of no great height, quite snowless, and generally very uninteresting in their aspect. The flat shelf-like surfaces of the parts of the alluvial valley-floor of *Purang* that have survived the eroding action of the rivers, were here very distinctly seen. They vary greatly in extent, and it is not possible to doubt that they have been originally continuous with the great plateau up to which we traced them in the next two days of our journey. I observed near the place of our encampment a very granitic or sienitic looking greenstone that I had not seen among the eruptive rocks we had before passed.

September 20. *Up the Karnali to Sing-lapcha*, 14 *miles*.—At 8 a.m., thermometer 37°·5. Our route lay over rounded hills of slates and limestones containing no definite signs of fossils, as barren as ever, and altogether very devoid of interest. An occasional patch of greener grass than usual gave our jhobus an opportunity of eating a little, an occupation in which they had been very seldom able to indulge for the last few days, so utterly barren had been the country; and as it turned out, during the remainder of the journey they were to fare still worse. We at length fell into a track said to be that from *Kangri* to *Darma*, and followed it into the valley of the *Karnali*, which river was here as large, or perhaps larger, than any of the streams we had before crossed during our journey in Tibet. Its main supply we could see to be derived from tributaries that rise on the northern slopes of the Indian watershed, in the neighbourhood of *Mangshang-Lekh*, one of the western passes of Byans. These feeders join the *Karnali* nearly at right angles just opposite to *Sing-lapcha*, above which the stream in the main longitudinal valley is a very insignificant one, and no doubt occasionally dry altogether. This circumstance gives additional weight to the views I have before propounded of the nature of the alluvial deposits along the *Karnali*. For those deposits manifestly follow the great longitudinal hollow which extends from *Khardam* to *Chujia-tol*, beyond which they cannot be distinguished from the general mass of the plateau of *Guge*; and they cannot, therefore, be derived from the present feeders of the river, which enter this valley at right angles at about the middle of its length, and at a point where no change of physical character is to be observed.

Sing-lapcha is so called from two or three piles of bits of stick, raised, as I before described, by travellers to form a "*lapcha*," the ordinary word for such a votive pile, *sing* or *shing* being the Tibetan for "wood." These piles, 4 or 5 feet in height, stand by the roadside on a prominent shoulder of mountain, which the track crosses about 500 feet immediately above the river.

In coming into the *Karnali* valley over the last of the hills we had to cross, we looked upon a flat alluvial terrace some height above the river itself, on which one of those optical illusions, to which I have before alluded, displayed an enchanted picture of a Tibetan encampment. There were the black yak-hair tents, the dark figures of men and cattle, and the white sheep scattered over the grass. But before I had reached the green pasture, the spell was dissolved; the tents were changed into great square blocks of stone, the men and cattle had shrunk into dark rocks and bushes, and where the sheep had been grazing just before, only white quartz boulders were now to be seen. Nor could I help thinking how easily, under the

influence of these or similar delusions, half-savage shepherds might accept as undoubted truths the wildest fables of wizards and enchanters, when in spite of my reason, and in the least romantic mood possible, I could hardly avoid giving a momentary reality to my vision.

As far as *Sing-lapcha*, hills of considerable height rose immediately from the southern bank of the *Karnali*, but to the west of this place they are somewhat thrown back, and a plateau, the surface of which seemed, on the whole, pretty level, though considerably intersected by ravines, bordered the *Chujia-Tol* valley, which, as I have already said, forms the prolongation of that of the *Karnali*. The foot of the hills on the north of the *Karnali* still kept close to the river, but their height above it gradually diminished.

The only object now remaining for us to accomplish was to return to *Kumaon*. We were satisfied that the Tibetan authorities, if by any chance they now discovered us, would simply assist us in carrying out this intention, and our people feeling, that they were by this time beyond the reach of the enemy, had no scruple in going boldly along the valley, and in encamping at a short distance from some Tibetan shepherds about a mile beyond *Sing-lapcha*.

The food of our Bhotiyas was by this time very nearly exhausted, so an expedition was at once undertaken to try to obtain a fresh supply, and at the same time to endeavour to buy a sheep or two, and, if possible, a goat with milk, the latter being a luxury that we had long been without. We were soon informed that almost all the men had gone from these tents to *Darchin*, in attendance on the Tibetan *Zhipchet*, then returning to *Lhasa* from *Gar*, which place the Bhotiyas more commonly call *Gartok*, and that only women and old men were left behind. Sheep were produced, but some difficulty was made about a goat; and we were referred to the headman of the community, whose tent was said to be 3 or 4 miles up the valley, for a supply of grain.

September 21. *Sing-lapcha to Camp near Lama Chorten*, 14 *miles*.—At 8 a.m., thermometer 33°; at 9 a.m., thermometer 47°. As we were preparing to start this morning, the flocks belonging to the Huniyas near us came down the valley close past our tents, escorted by a wonderful-looking shepherd dressed in sheepskins, and altogether the most uncivilized-looking creature conceivable. His ideas were evidently rather limited in their range, and though he thought it rather odd, he was perfectly satisfied when he was informed that we were a peculiar sort of Juhari. He only wished to know whether we had been on a religious pilgrimage to *Manasarowar*, his education not having got so far as to make him aware of the existence even of his "*Feling*" neighbours. An attempt was made to induce him to let us have a goat. This he totally refused to do, and when our people insisted, he went back, in a violent state of indignation, to his camp to report their misconduct, and, when the matter was at last settled, returned to his flock still quite unpacified. Our road led us right up the valley, and we passed the tents where our sheep had been kept for us, and after a great deal of talk, the purchase of the goat was amicably arranged by our being allowed to carry it off at an exorbitant price.

Chujia-tol, the name of this part of the valley, was the greenest place that we had seen since we left *Gyanima*. The word *tol*, which, however, does not appear to be classical Tibetan, is applied, as well as I could make out, not merely to the locality, but to the whole pastoral establishment by which it is occupied, something as the term *village* designates a settled agricultural community, with their abodes. The population here was not by any means numerous, and we may have passed fifteen or twenty tents at the outside. The people were exclusively nomadic and pastoral, having no homes but their tents, pitching these at such distances from one another that their cattle should have grazing-ground enough, and moving their

encampment to other ground as the grass was eaten up, or as the season required. This community, we were told, went northward in the winter towards the *Satlaj*, or beyond the lakes, all the country along the Indian watershed and south of the lakes being then uninhabitable from the great depth of the snow. They have a regular routine of grazing-grounds, which they occupy to the exclusion of all other persons, and in which they are held to have a hereditary property.

With the exception of the monasteries about the lakes, *Kyunglung* and *Khardam* are the highest permanently inhabited places in this part of Tibet, and they are between 14,000 and 14,500 feet above the sea. The fixed population in these places, other than the monks, is, as usual, agricultural; but the remainder

TIBETAN SHEPHERDS.

of the secular inhabitants of the regions we had traversed are entirely nomadic and pastoral in their habits.

As we passed up the valley we at length reached the tent of the headman, who, with his wife and children, came out to receive us, he presenting the scarf of ceremony, and the lady a bowl of milk. After a short preliminary conversation, carried on through the medium of our Bhotiyas, for I did not understand a word of Tibetan, we proposed to go into his tent, and he was most happy to see us. We were soon joined by some of the *élite* of the society of *Chujia-tol*, but, the men being absent, our visitors were nearly all women.

The men wore a loose gown tied round the waist, which, if not black naturally,

had at all events become so by dirt. They had high cheek-bones, oblique eyes, dark complexions, and their hair was worn with long tails, their rough and battered looks showing the hard life they must lead. Among the more prominent of the various parts of their costume and its accessories were a grey felt cap, the edges of which are turned up all round; cloth boots, called *lam*, of various bright colours, mostly red and green, with leather soles; and a belt, from which is hung a great array of purses, pouches, knives, pipes with apparatus for striking a light, etc. Also should be mentioned the brass box almost invariably hung round their necks or over their shoulders, containing either charms or, maybe, their Penates in the form of a clay figure of *Buddh*, made at Lhasa and blessed by the great lama. These figures, however great may be their spiritual value, do not bear an extravagantly high price in the worldly market, for I found that a Tibetan was very willing to overcome his scruples and part with his consecrated *Buddh* for a matter of some four or five rupees.

The women—I cannot call them the fair sex—were gowned and booted much as the men; but they were chiefly conspicuous for their peculiar head-dress, apparently a triangular board covered with cloth, which is fixed on the top of the head, the apex turned behind and prolonged down the back into a tail of leather decorated with a profusion of pieces of brass, turquoises and other stones, and bits of glass, with rows of little silver coins hanging from its edges. The hair under this curious apparatus is plaited in front in many separate little braids, and a grand natural tail hangs down behind, which produces, with the artificial one, an effect which would not a little surprise the coiffeurs of Paris. The ladies' toilet was completed by a tremendous chatelaine, which seemed to contain all conceivable implements ever invented for the use of a Tibetan household.

The tent was made of black yak-hair cloth, 15 or 20 feet long, and half as wide supported on three upright poles connected by a horizontal ridge piece. The ridge was open at the top, all along the middle, to let out the smoke, the fires being arranged between the poles on the ground below. The doorway was at one end, and closed by blankets that hung before it. At the opposite end, on a little sort of table, were set up the household gods, having a number of small brass cups arranged in front of them to contain their food, which is a mixture of butter and meal. The head of a goat lately killed lay in front of the deities for their use, but the eatable legs and shoulders had judiciously been reserved for the mortals. A large assortment of pots and pans, of wood, iron, and copper, stood along the hearth-range, and amongst them I need hardly say was a kettle of tea, with a mess of porridge of buckwheat flour.

Literature and the fine arts appeared not to be altogether neglected in the Tibetan camp; writing materials, ready for the man of business or the scholar, and a stringed instrument of the guitar fashion for the poet or musician, formed part of the furniture of the tent. Outside was a large wooden shovel, used to clear away the snow.

Our host's name was *Angchu*, an oldish gentleman, and as we sat in his tent, Mr. Winterbottom was engaged in sketching the inmates, while with the help of an interpreter I carried on the conversation. Although head of this community, Angchu said that he had no perquisites in that capacity—nothing, indeed, but the honour of the thing, and that he was only kept in this position for the purpose of giving the authorities some one through whom they could act in their dealings with his people. This statement of Mr. Angchu is, I fear, not strictly correct, but his emoluments, no doubt, are not very great, and there was probably some ground for his grumbling. These nomads appear to pay no regular taxes to the state, but to be generally squeezed. Thus they supply food and carriage to the Lhasan

officers when they move about the country; they are compelled to buy their tea, and the scarfs of ceremony, and perhaps other things of which a Government monopoly is established, from the Tibetan officials, paying for them prices which they aver are three or four times what they ought to be. They also have to give up to the Government one load in ten of the salt or borax which they collect.

They are altogether dependent on barter for their supplies of grain; parties with sheep and goats are sent to the mountains north of *Kailas* to collect salt and borax, and they exchange these for the cereals which they require.

Their domestic animals comprise sheep, goats, yaks, ponies, and dogs. They make butter and a sort of cheese from the goats and cows' milk. The best butter would be very good if it were not ruined by dirt, and filled with an unlimited quantity of hair. The coarser hair of the goats is used for making ropes; the down under the hair is the shawl wool, or *pashm*, and its growth is altogether

TENT OF ANGCHU, WITH HIS WIFE AND CHILDREN, RECEIVING OUR VISIT.

dependent on the cold of the climate in which the animal is bred. The sheep produce wool only. The hair of the yaks is employed in making the coarser cloths, such as those used for tents.

The goats are usually branded in the horn. The sheep are marked with red ochre, much as in England, but not quite so neatly. Unlike the Hindu agricultural people, they only keep one bull yak in each village or nomad community, and we saw him on our way up the valley, looking very large, fierce, and shaggy, high in his fore quarters, and low behind—very much resembling the form of the bison. The young bull reserved to replace the old one was also pointed out; he was marked by a tassel fixed in his ear.

We stopped about an hour at the Huniya's tent, during which time sufficient grain had been purchased to last till we fell in with the convoy ordered to meet us at *Tazang*, where we hoped to arrive in two days' time. Starting once more, we again followed up the valley as before, its depression below the highest level of the alluvial deposits, which here had a considerable development on our right, gradually diminishing, till at length we once more found ourselves on a level with the surface of the extreme south-east angle of the great plateau itself. We encamped not far from *Lama Chorten*, about 200 feet above the plain, at the foot of a spur from the Indian watershed, which rose steeply on the south above our tent. On the north the hills terminated nearly opposite to us, so that we looked across the plain without interruption for many miles in the direction of the lake of *Gyanima*.

We had now returned to within a short distance of the *Darma Yankti*, on which we had encamped some miles lower down on the 11th of the month on our way to *Rakas-tal*. This river rises from glaciers on the north face of the Himalaya, and the roads from the *Kach*, *Nuye*, and *Lankpya* passes all lead down

some one or other of its feeders. It appears as if there were here some suppression of the ordinary outlying spurs of the watershed ranges, and perhaps even a depression in the ridge itself. Up the *Darma Yankti* we looked into a wild and ghastly gorge, filled with snow and ice, down which howled a furious wind, pouring out a great fan-shaped mass of cloud over the gap, at the mouth of which we encamped. A little snow fell near us, but the cloud was dissipated before it spread very far over the plain, reabsorbed under the influence of the greater heat and dryness of its open barren and arid surface.

September 22. *From Camp near Lama-chorten to the Gunda-Yaukti, 7 miles.*—At 6 a.m., thermometer 21°·5; at 9 a.m., 43°·3. The man sent this morning as usual to bring water for our use, returned with it in a blanket, in the shape of lumps of ice, the stream from which a supply had been got the evening before having been frozen solid during the night. The cold by this time had become rather severe at night. The contents of our teapot, which we used the last thing in the evening, were usually found to be frozen hard before morning, lying on the ground beside us as we slept; and to-day we had an additional example of the extreme cold. We had filled a bottle with milk got from the Huniyas of Chujiya-tol, and it was left in a basket outside the tent. During the night it froze into a solid mass and broke the bottle to pieces, but as this was discovered before it began to melt, no harm was done, and we were more careful in future. Our tent, being made to open all along the top to let out the smoke, as I before explained, let in a great deal of cold air, in spite of all attempts made to fasten up the chink, and the temperature inside in the morning was nearly that of the external air; but in spite of the cold we got on pretty well.

In approaching the *Darma-Yaukti* we came upon an elevated mound of detritus the origin of which was at first difficult to understand, but I was soon satisfied that it must have been the moraine of an old glacier. The breadth of this remarkable mass of detritus was about 3 miles where we crossed it, divided down the centre by the river, to which it forms what at first sight were two ordinary alluvial banks. It extends 3 or 4 miles below the point where the river quits the mountains, and its highest points are perhaps 200 or 300 feet above the plain, from which it rises steeply. The summit was covered in a striking manner with small hollows of more or less circular outline, in no way communicating one with another, their sides sloping steeply inwards to a flat muddy bottom, such as might have been formed by the gradual melting of ice covered by moraine detritus. In other respects, also, the material of which the mass was made up had all the characters of a glacier moraine, and was certainly neither drifted gravel nor water-worn shingle. I had not satisfied myself of the true nature of these mounds, when to my surprise I found another accumulation of precisely the same nature, along the Gunda Yaukti, on which river we halted for the night. The interval between the two old moraines—for such they certainly are—is precisely on the same level as the great plain, or, more correctly, is actually a part of it, and it hence became evident that the mounds over which we had passed must have been formed along the rivers, and the agency of glaciers readily suggested itself. A very similar mass of detritus to that we found here would be formed now by the dissolution of a glacier such as that of Milam, the lower part of which is for many miles entirely covered with great quantities of rocky detritus, with isolated hollows and pools of water scattered over it. The disappearance of the ice from beneath this detritus would leave a condition of the surface in no way differing from that observed on the top of these mounds, the formation of which it would otherwise be difficult to explain. I shortly afterwards noticed something of the same description on the flank of one of the mountains near *Unta-dhura*, on our way back to *Milam*, where an accumulation

of rubbish, with several small pools of water on it, blocks up the end of a ravine —the result, no doubt, of the destruction of a small secondary glacier.

A very cold and violent wind again blew to-day from the recess in the mountains at *Lama-chorten*, and we saw that a fall of snow was taking place at the entrance of the gorge from which the *Darma-Yaukti* issues into the plain of *Guge*. To-day as we went along the plain we noticed the *Ephedra Gerardiana* in considerable quantity, with its red fruit now quite ripe.

September 23. *From the Gunda-Yaukti to Tazang*, 9 *miles*.—At 6·30 a.m., thermometer 15°·5; at 7 a.m., 23°·2. There was a good deal of ice on the *Gunda-Yaukti* as we crossed it this morning, and the stream was considerably less in volume than it had been when we came to it in the afternoon yesterday. We were here visited by a pair of great ravens, which had managed to find out our tent in the middle of this wilderness. Exhibiting the ordinary impudence of such birds, one of them fell a victim to Bachu's gun. He turns out to be identical with the great European raven. So, also, it is curious to find that the common magpie of Tibet is the ordinary English species. The simultaneous discovery, on crossing into Tibet from the Himalayan watershed, of so many European forms, whether in the animal or vegetable kingdoms, is manifestly no mere accidental coincidence.

Leaving the ancient moraines of *Gunda-Yaukti*, we again descended to the level of the plain near the origin of the ridge called *Temba-dhar*, which separates the headwaters of the *Gunda-Yaukti* from those of the *Chu-naku*. We here managed to catch one of the rat-like animals we had seen at Gyanyima. The only new plants were *Biebersteinia emodi*, *Euphorbia tibetica*, and *Scirpus caricis*, with *Agropyror longe-aristatum*, a grass which is found at all elevations above 5000 feet. The botanical and zoological curiosities of this barren region were by this time well-nigh exhausted, and the tedium of our last few days was chiefly relieved by the consciousness that we were very speedily to be released from the discomforts of our Tibetan journey.

The *Chu-naku* was a small clear stream sunk only 20 or 30 feet below the general level of the plain, and shortly after crossing it we once more entered the outer ranges of the Indian watershed, and, following up a ravine with low hills on either side, we encamped at last at *Tazang*. This is one of the chief places where the Juhari Bhotiyas carry on their traffic with the Huniyas, bartering grain for salt and borax. It is said to be a good grazing-ground earlier in the season, but not a vestige of anything for the cattle to eat was now to be seen. The men were more fortunate, for we found that the provisions we had ordered had been waiting for us for the last day or two, and as the weather seemed quite settled, it looked as though our expedition would end with complete success. A little anxiety had at times been evinced by our Bhotiyas lest bad weather should come on, in which case we might have got into difficulties, for the passes from *Milam* into Tibet are sometimes permanently blocked up with snow for the winter by a fall late in September. In that case we might have had to go round by the *Niti* pass, which can be crossed in fine weather all the year round, but this would have been excessively inconvenient, as we could not then have got back to *Milam*, where we had left our servants, tents, and other effects, under three weeks or a month, there being no passage from *Niti* to *Milam* after *Unta-dhura* is closed, except by making a *détour* to the south of 150 miles.

It will serve to show the somewhat indefinite character of the names of places in these regions when I mention that the term *Tazang* is applied to three distinct localities in this vicinity, within 2 or 3 miles of one another. To prevent confusion they are distinguished by the Juharis by the additional affixes *Sukha*, "dry;" *Lam*, "snow-boot;" and *Huniya*, Tibetan. That at which we encamped was

Lam Tazang, where the tents of the *Patwari*, or headman of Milam, are commonly pitched. Others of the Bhotiyas go to *Sukha-Tazang* or to some intermediate point in the ravine between these two places, and the *Huniyas* frequent the spot called after them. It will be easily understood that, with the numbers of sheep employed in this trade, it is necessary that there should be a certain amount of elbow-room allowed between the different camps.

As we arrived at the end of our march rather earlier than usual, the following notes were made of the temperature :—

p.m.			Air.			Wet Bulb.
At 4·0	...	...	42°·7	...	...	29°·8
„ 5·0	...	...	35°·4	...	...	25°·1
„ 6·0	...	...	30°·2	...	...	24°·6

This indicates the extreme dryness of the air.

September 25. *Tazang to Chirchun*, 10 *miles*.—At 8 a.m., thermometer 32°; at 9 a.m., 35°; at 10 a.m., 40°·5. We had now again fairly got among the mountains, and the road gradually became more rugged as we proceeded. The rocks

Chor-hoti pass, 18,000 feet. Malchak peak, 19,800 feet.

RAJ-HOTI VALLEY, 14,900 FEET.

were chiefly of limestone, and the greatest confusion prevailed in the disposition of the strata, though, as usual, on the whole they dipped northerly.

In our way along one of the ravines we came upon the remains of an old dry stone wall, which we were told was a traditional boundary between Tibet and *Juhar*, though regarding the time or manner of its construction nothing was known. I do not think that our Bhotiya subjects have any definite ideas as to the boundary between the British possessions and those subject to Lhasa; nor indeed am I aware that any boundary has ever been settled between the two powers. We English in Kumaon affirm that the watershed is the boundary, and I think no one will dispute the assertion. I was indeed told that *Hoti*, a pasture ground north-east of *Niti* within the watershed, was considered by the Tibetans to be a dependency of *Daba*. But as it was convenient for me to consider it British ground when I was geologizing here in the following year, I did not find any one, either Bhotiya or Tibetan, inclined

to deny my positive assertion that it was British. A dispute about a few square leagues of snowy range will hardly give rise to a *casus belli* between us and the Government at Lhasa, and the geographers on both sides may, I think, be safely left to put the boundary in their maps where they please.

In descending into the most eastern of the main feeders of the *Chirchun* river, we crossed limestone strata filled with fossil shells. These were probably the Cretacean beds overlying the Jurassic strata, which immediately afterwards we came upon in the Oxfordian black shales, which continued up to the main branch of the river. This runs in a very wide shingle bed, probably a mile across, through these disintegrating strata, and, following it up about a mile further, we reached the halting-ground on its left bank called *Chirchun*. A second feeder of the Chirchun river, rising from a glacier that we saw about 2 miles off, joins the main stream just where we crossed it.

Chirchun is about as miserable a place to stop at with cattle as can be well imagined. The flat ground is covered with loose rotten shale without a particle of vegetation on it, and on the hills around there is an almost total absence of vegetable life. At this season the leaves of the few stunted plants that were to be seen had already become parched up by the severe night frosts, and our wretched cattle had to pass another day with nothing to eat but the dry twigs of the *dama* bushes. The feet of nearly all the jhobus were getting affected by the rough ground we had been going over, and one of them to-day fell so lame that, on coming to a green bit of ground, it resolutely resisted all attempts to drive it on, and was there left for the winter, as we supposed, to perish. I confess I was rather astonished the following year, when I was told that the animal had been found again in capital condition near the place where it had been left by us. What it had found to eat during the interval is more than I can imagine, but it was, I suppose, as well off as the wild sheep and yaks and other animals of Tibet at large.

In the course of the evening a considerable commotion took place in our camp, caused by the appearance of a solitary dog, who was on his way from Milam back to his fatherland Tibet. It was supposed that he had been sold or given to some Bhotiya, but that he declined to remain at Milam, a thing said often to happen. As it was probable that the animal was hungry, there was no little alarm lest he should come and eat up anything he could find during the night; to such an extent, indeed, was the anxiety of our Bhotiyas carried, that they thought it worth while to post a sentry to keep him off.

At 9 p.m., thermometer 25°·5.

September 25. *Chirchun to Shelong*, 17 *miles*.—Having a long day's work before us, which included the crossing of three passes between 17,500 and 18,500 feet in altitude, we started this morning soon after seven o'clock. The ascent commenced immediately, and was pretty easy the whole way up the first pass we had to cross. At first we went over solid limestone rock, but as we rose we again came to the Oxfordian shales, which continued to the summit of the ridge, where parts of them were quite filled with belemnites. We reached the crest of the first pass, *La-Khur*, 18,170 feet, at a little before eleven o'clock, thermometer 27°·3, having been not quite four hours in accomplishing the ascent of 2410 feet. The sky at this time was quite cloudless, and though we were somewhat shut in by higher ridges close to us, we still had a wonderful view of the world of mountains by which we were surrounded. There was little that resembled the grand prospects of the outer Himalaya, where the eye may sweep at a glance over nearly 200 miles of the chain, and trace from their great snowy axis mountain after mountain and range after range gradually unfolding themselves, till the entire circuit of the horizon is filled with the outlines of their countless ramifications,

the dark purples of the distance imperceptibly melting into the liveliest tints of the foreground, the ridges clothed with forest, and the valleys enlivened by fields and villages. Unlike this, we here stood in regions where the lichens on the rocks were the last refuge of vegetation. Shattered cliffs and impassable precipices, capped with eternal snow, frowned upon us from every side. Yawning chasms, long barren slopes of loose stones, and the desolation of glaciers lay at our feet. The mountains that bounded our view stood out hard and cold against the clear blue sky, piled one behind the other in a chaos of confusion, neither softened in outline or colour by atmospheric influences, nor relieved by any trace of life or verdure. Among the peaks that I recognized was *Nanda Devi*, distant about 20 miles, which rises to 25,400 feet; but our map, when we passed, was not nearly so perfect as it now is, and in such a scene it is extremely difficult to distinguish the ridges and peaks without a good map to assist the eye.

On this ascent the vegetation was most scanty, the last plant seen being the nettle *Urtica hyperborea*, before noticed, which came up probably above 17,500 feet. From the pass we looked down over two glaciers. That to the east along the side of which we had come gives rise to the principal feeder of the *Chirchun* river, and communicates by a great *névé*, over the pass called *La-sar*, with another glacier, over which, as I before mentioned, ineffectual attempts had been made to establish a direct communication from *Dung* to *Chirchun*. The glacier to the west of the pass supplies the chief feeder of the stream that flows under *Topidunga* and *Girthi*, and our road lay down it. The descent was fearfully steep, over a cliff of limestone interspersed with the great slopes of loose sharp fragments of rock that are so characteristic of these mountains above the limit of vegetation. For the first time since quite the beginning of our journey, I thought the descent so bad that I would not ride my jhobu down it, though, in fact, it would, I believe, have been safe enough to do so. The slopes of loose sharp angular pieces of limestone lying at their natural angle of repose, between thirty and forty degrees from the horizontal, varied here and there by a step of solid rock polished by the feet of men and cattle, down which, slippery as they were, the jhobus had half to jump, half to slide, did not afford an inviting prospect for such a ride; a false step must have shot the rider over the animal's head, and he would then, without fail, and in an incredibly short time, have been added to other rubbish on the moraine of the glacier below.

We managed, however, to reach these moraines in a more convenient manner. We found them and the lower part of the glacier generally very black from the dark shales and limestones which are here the prevailing rocks. Crossing the glacier, we went up the opposite moraine, and a steep pull brought us to the summit of *Jainti dhura*, the second high ridge we had to go over, at about half-past one o'clock. This point was about 18,390 feet above the sea, and is one of the highest passes that I have crossed. The thermometer in the air stood at 29°·2, the soil one foot below the surface being 31°·5.

Jainti is merely a short projecting spur from the *Unta-dhura* watershed ridge, over which the route from *La-khur* to *Unta-dhura* crosses. From it rises a peak that reaches an elevation of perhaps 19,000 feet, a little to the north of the point where we crossed it, and beyond this it ends abruptly in a precipice over *Topidhunga*. Being thus thrust out, as it were, from among the surrounding great ridges, though it is probably as high as most of them, the view from *Jainti-dhura* is grand in the extreme.

In passing through the highest portions of these mountains, the traveller, who naturally expects to find scenes of surpassing grandeur in the midst of their gigantic snow-clad pinnacles, is too often doomed to disappointment, and in his

painful progress along the narrow gorges he seldom sees anything beyond the rocks that frown immediately over his head. Exceptions there are, however, and the scene that we here had presented to us was among these so often hoped for, but so seldom found; nor do I ever remember to have beheld, either before or afterwards, such a stupendous chaos of mountains, of the effect of which on the mind no description could convey an adequate conception. It was a brilliant day; the wind not too strong, and the intense power of the sun was agreeably subdued by the fleecy white clouds which hung about the higher peaks, or floated off from them in the fresh breeze until they disappeared in the blue sky of Tibet. High health, the feeling of exhilaration felt in sharp and dry air, and the satisfaction which we experienced at the successful termination of our journey, prepared us to enjoy whatever we saw. Nor are the silent and almost unperceived suggestions of scientific culture among the least important agents in producing the emotions of wonder that fill the mind in gazing on such scenes, where the relics of the ocean-beds of an almost measureless past, piled one on another at these stupendous elevations, display the vastness of the powers of nature, into the operations of which we strive not too successfully to inquire. The glacier along which we had just come descended thousands of feet below us, and gave birth to the *Girthi* river, a torrent the course of which was marked by a streak of foam along the great gulf into which we looked. A huge rock rose from the middle of this glacier, throwing off the frozen stream on either side in great wave-like cliffs of ice. *Unta-dhura*, the first pass we had crossed on our way into Tibet, we now saw, not a little to our surprise, almost at our feet, 800 feet below us. Yet no snow lay on the ridge on which we stood, neither had we hitherto crossed any snow in our ascent either on the *La-khur* pass or to the still higher spot where we then were. Of vegetation there was no vestige, excepting far down in the gorge of *Topi-dunga*, beyond which towered *Kamet*, the great peak of the *Garhwal* watershed, 25,502 feet in altitude.

The cliffs that flank *Topi-dunga* on the south are of Upper Silurian age, and are violently shattered and most precipitous. The order of succession of the beds, which extend from Silurian to Carboniferous, is strongly marked by their vividly contrasted colouring. Grey, black, and dark red, having a pale band of quartzite on the top of all, which looked almost ghastly among the snow that lay thick upon it. The escarpment of Kyungar facing the south-west is as abrupt as is well possible, but is topped with a less rugged and more swelling outline. It is composed of Triassic and Rhœtic capped with Cretaceous beds, and a continuation of it, no less precipitous, extends beyond *Girthi* along the north bank of the *Hoti* river. Beyond *Hoti* the continuity of the ridge is broken, but as a geological feature the escarpment can again be recognized at the *Niti* pass.

An easy descent brought us to the north foot of *Unta-dhura*, where we found that fresh snow had fallen since we had crossed. The old snow, which must have been the accumulation of former years, was distinguished by an appearance of stratification caused by the edges of a succession of icy bands projecting obliquely from the general snow surface, with as many intermediate layers of softer snow between them. The lamination may be readily understood as the effect of the freezing of the surface of successive falls of snow, and is commonly to be seen in similar circumstances. It was in the hollow between *Jainti* and *Unta-dhura* that I noticed the remains of the old glacier which I mentioned when describing the old moraines on the *Darma Yaukti*. On the summit of *Unta-dhura*, which we reached at a quarter to three, there was no vegetation whatever, excepting a few lichens on the shattered rocks that crown the ridge. The thermometer was now at 31°·2.

I have already described the route from *Unta-dhura* to *Milam*, which we now

again joined, and I need only add that our descent was undertaken under very different auspices from our ascent. Our return journey over these passes had, in fact, been anything but painful, and there was, I think, no day which we had spent so agreeably since we left *Milam*. We were, however, late in reaching *Shelong*, chiefly from the cattle being generally knocked up by want of food, and from many of them having sore feet. This indeed had got to such a pitch that their track was marked over the glaciers in blood, but it was impossible to loiter; nor could we halt at *Dung*, for there was not a scrap of wood nor a blade of grass to be got there.

We ourselves arrived at *Shelong* shortly after seven o'clock in the evening, having been nearly twelve hours on the road; but the tents did not come up for a long time, and we had an opportunity, as we sat in the open air by a fine blazing fire of juniper, such as had not rejoiced us for weeks, of admiring the genial warmth of the climate of a spot only 12,500 feet above the sea-level. The following morning, September 26, we returned to *Milam*.

The day after our arrival at Milam, a Huniya arrived from Dungpu, a village near the Satlaj, sent by the Zungpun of Daba, who had by this time become aware of our having gone into Tibet, to inquire where we had been, and to see whether we had come back. The zungpun had sent his emissary from Dungpu, as he passed that place on his return home from Darchin, where he had been to meet some Lhasan officers, probably those we had heard of at Chujia-tol. He had no definite knowledge of our movements, but had heard that we had crossed the frontier. I desired a message to be sent in return to tell him exactly where we had been, and I added, that if it suited me to go into Hundes again next year I should certainly do it. I had no idea at the time of doing anything of the sort, but I did actually carry my threat into execution. At the same time it must be said that it is very doubtful whether my message was ever delivered to him.

Note on Himalayan Glaciers.

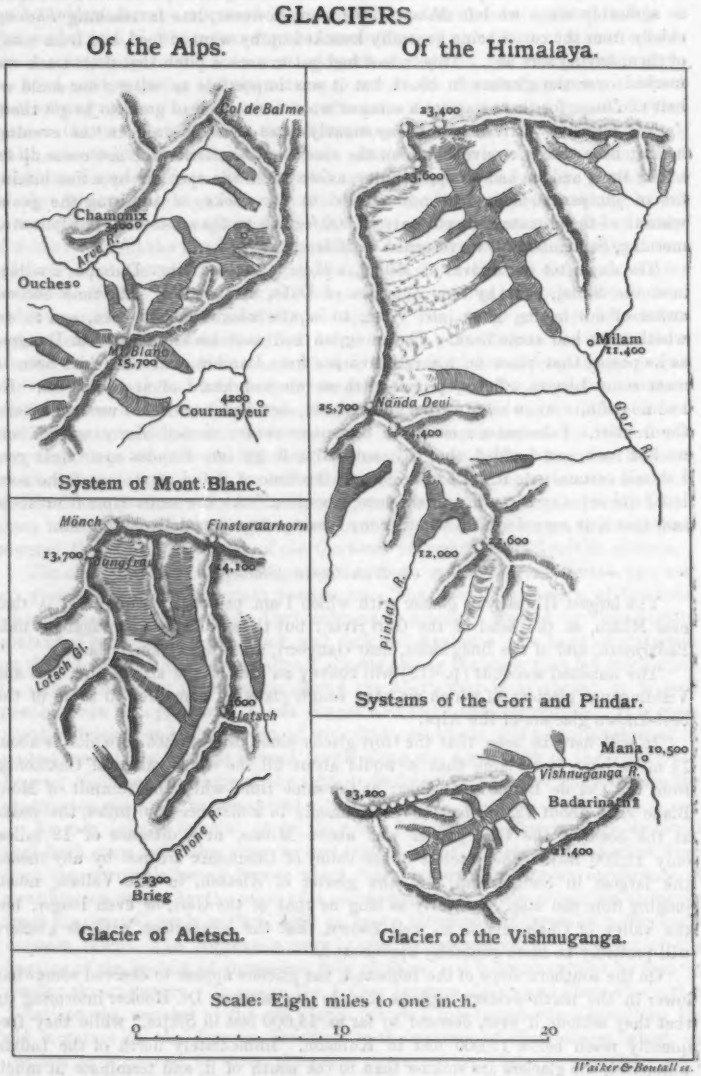
The largest Himalayan glacier with which I am personally acquainted is that near Milam, at the head of the Gori river; but those of the Vishnuganga, near Badarinath, and of the Bhagirathi, near Gangotri, are also extremely large.

The annexed woodcut (p. 412) will convey an idea of the size of the Gori and Vishnuganga glaciers, of which we have rough plans, as compared to some of the best-known glaciers of the Alps.

It will here be seen that the Gori glacier alone, the surface of which is about 11 miles long, is so large that it would about fill the whole valley of Chamonix, from the Col de Balme to Ouches; at the same time, while the summit of Mont Blanc rises about 12,300 feet above Chamonix in a distance of 6 miles, the peaks at the head of the Gori glacier rise above Milam, at a distance of 12 miles, only 12,200 feet. The glaciers of the valley of Chamonix are not by any means the largest in Switzerland, and the glacier of Aletsch, in the Vallais, must, judging from the map, be nearly as long as that of the Gori, or even longer, but the valley of Chamonix is so well known, that the comparison with its glaciers will probably be more generally appreciated.

On the southern slope of the tableland, the glaciers appear to descend somewhat lower in the north-western regions than in the eastern; Dr. Hooker informing us that they seldom, if ever, descend so far as 14,000 feet in Sikim,* while they frequently reach below 12,000 feet in Kumaon. Immediately north of the Indian watershed, the glaciers are smaller than to the south of it, and terminate at much higher levels, varying from 15,000 to 17,000 feet; in the central parts of Western

* 'Himalayan Journals,' vol. ii. p. 57.


GLACIERS
Of the Alps.
Of the Himalaya.
Col de Balme
Chamonix
3,000
Arve R.
Ouches
Mt. Blanc
15,700
4200
Courmayeur
System of Mont Blanc.
Mönch
Finsteraarhorn
13,700
14,100
Lotsch Gl.
2600
Aletsch
Rhone R.
2300
Brieg
Glacier of Aletsch.
23,400
23,600
Milam
11,400
25,700
Nanda Devi
Gori R.
12,000
Pindar R.
Systems of the Gori and Pindar.
Mana 10,500
Vishnuganga R.
23,200
Badarinath
21,400
Glacier of the Vishnuganga.
Scale: Eight miles to one inch.
0
10
20
Walker & Boutall sc.

Tibet they appear to be comparatively rare and of small dimensions; but on the Turkish watershed they again become much larger, and some of them come down even a little below 12,000 feet, though others on the same range terminate as high as 15,000 feet.* In the countries north-west of the Indus, near Gilgit, Mr. Winterbottom found one of the glaciers to descend as low as 8600 feet.

The variations in the levels to which these glaciers descend must, in a great degree, depend on the peculiar circumstances of each individual locality, though the mean temperature of the place will of course, to some extent, regulate their general elevation, and the summer temperature will give a negative limit, beyond which they can never pass. The two chief factors of these variations will be, first, the extent and elevation of the snow-basin that feeds the glacier; and, second, the slope of the surface along which the glacier travels. It will be seen, on a moment's consideration, that if two glaciers are formed on opposite faces of a ridge like the Indian watershed, which descends on the south side from 18,000 to 11,500 feet in a direct distance of 10 miles, while on the north the descent is only from 18,000 to 16,000 feet in the same distance, a south glacier of 10 miles long will arrive at a level of 11,500 feet, and a north glacier of the same length only 16,000 feet. If the feeding snow-basin is larger on the south face, the additional waste from the glacier descending into warmer regions may be easily countervailed, but no imaginable increase in the supply of snow would be likely to carry the north glacier to such a level as 11,500 feet, which it might not be able to attain without an extension of its length of 100 miles or more. These considerations, combined with the known diminution in the fall of snow in the interior of the chain, appear to be sufficient to account for the higher level at which the glaciers terminate to the north of the Indian watershed, without supposing any special action of climate as has been suggested.

No really satisfactory conclusion can be come to regarding the cause of the lower level to which the glaciers of the Himalayan slope descend in Kumaon, as compared to Sikim. Judging from the somewhat greater elevation to which forest extends in Sikim, we may, perhaps, have some reason to infer a rather higher mean temperature at like elevations in Sikim than in Kumaon, which, indeed, might be considered a natural result of the lower latitude of the former; but our thermometric data are not sufficient to settle the point directly, and the climate of Sikim being so much more wet than that of Kumaon, it would be unsafe to make use of mere *à priori* arguments.

For similar reasons, it is hardly possible to institute any proper comparison between the glacial phenomena of Europe and the Himalaya, but the following points may be noticed:—

	Heights above Sea-level.				
	Europe.		Tibeto-Himalayan System.		
	Norway.	Alps.	South of Indian watershed.	North of Indian watershed.	Turkish watershed.
	Ft.	Ft.	Ft.	Ft.	Ft.
Snow-line	3000-5500	8500	16,000	18,000	20,000
Glaciers end ...	0–1500	3500–6000	11,600–13,000	15,000–16,000	11,800–15,000
Glaciers descend below snow-line ...	3000–4000	5000–2500	4400–3000	3500–2500	8200–5000

* *R.G.S.J.*, vol. xxiii. p. 52; Thomson's 'Travels in Tibet.'

From these figures it will be seen that the range of glaciers compared to the snow-line, is very similar in Europe and on the Himalaya, though in Northern Tibet, in one well-ascertained instance, in Yarma-Nubra, a glacier is known to descend more than 8000 feet below the limit of perpetual snow. The glacier seen by Mr. Winterbottom, north of Gilgit, coming down to 8600 feet, that is, perhaps to more than 10,000 feet below the snow-line, is yet more extraordinary; but the elevation is not so well determined in this case; nor have we any direct evidence as to the height of the snow-line on the mountains in this quarter, though from the general arid character of the country, we have no reason to suppose the climate to be more wet than Northern Tibet generally, or that the snow would lie lower there than on the Karakorum pass, where it has been estimated by Dr. Thomson not to come below 20,000 feet. This point is worthy of the attention of travellers in these countries.

In the absence of satisfactory records of the thermometer at places on the Alps, near the termination of a glacier, I have calculated the mean temperature of three of the hottest months for Chamonix, by interpolation, in proportion to its elevation, between Geneva and the Convent of St. Bernard, and I find them to be—July, 61°; August, 61°; September, 55°. Taking Vevay as the lower station, instead of Geneva, which appears abnormally hot, the temperatures would be—July, 59°; August, 57°; September, 52°. For three years the mean temperature of Zermatt was, for July, 56°; August, 51°; and September, 49°. At Grindelwald for two years: July, 60°; August, 57°; and for one year: September, 50°. These figures may be compared with the mean observed by myself at Niti, at 11,600 feet, the extreme limit of glaciers in Kumaon, which will be seen to be nearly the same, namely, July, 58°; August, 58°; September, 55°. So, too, in Norway, the approximate summer temperatures at the termination of the southern groups of glaciers, which descend to about 1200 or 1300 feet above the sea, may be taken at 4° less than the mean of Bergen and Drontheim, that is, July, 59°; August, 55°; and September, 50°. And for the more northern regions, where the glaciers reach to the sea-level, we might have temperatures intermediate between Drontheim and Alten, or July, 60°; August, 57°; and September, 49°. From this, it would appear probable that the extreme limit to which glaciers can reach will not have a mean temperature of the hottest month exceeding 59° or 60°.

All the phenomena of glaciers seen elsewhere are to be observed on those of the Himalaya and Tibet, and, with two exceptions, they will require no special comment.

The first of these is the velocity of the motion of the ice, which must, of course, greatly depend on the circumstances of each particular case; but an analogy with the motion of the glaciers of the Alps is sufficiently shown by the few observations I have made in Kumaon. The mean of four days' motion in May, on the glacier at the source of the Pindar, gave a velocity of about $9\frac{1}{2}$ inches for the twenty-four hours, for the central parts of the ice, about $1\frac{3}{4}$ mile above the terminal cave. The same glacier, from May 21 to October 15, moved over $98\frac{1}{2}$ feet, being at the rate of just 8 inches in the twenty-four hours.* The motion of the centre of the great glacier of the Gori, 7 or 8 miles from its lower extremity, was 38 feet, between August 29 and September 30, being at the rate of about $14\frac{1}{4}$ inches in the twenty-four hours. In juxtaposition with the above, I may add, that the motion of the Mer de Glace, as measured by Prof. J. Forbes, varied from 27 to 9 inches in twenty-four hours in different parts of the glacier and at

* For details of the first measurements made by myself of the motion of the Pindari glacier, see *J.A.B.S.*, vol. xvii. p. 203.

different times between the months of June and September; the mean at a central point (L'Angle) being about 13½ inches in twenty-four hours for the three months of July, August, and September.* The motion of the middle part of the glacier of the Aar is also stated by M. Martins to be 71 mètres per annum, which amounts to 7½ inches in twenty-four hours.†

THE DATE LINE IN THE PACIFIC.‡

Dr. A. M. W. Downing, F.R.S., has kindly supplied us with the following. He has also obtained permission for the reproduction of the interesting map which accompanied his paper.

The point to which attention is drawn in this paper is this: Where does the day change for the portion of continents and islands which are contiguous to the 180th degree of longitude? or, in other words, what is the course of the date line (as it is called) from the arctic to the antarctic regions?

It is obviously most convenient that the date line should approximate, as closely as political and geographical circumstances will admit, to the 180th degree of longitude. Prior to about the middle of the present century this was far from being the case. Up to that time the Philippines kept the American date, owing to the fact that the Spaniards originally approached those islands from the Pacific coast of America. Thus Luzon and Celebes, though on the same meridian, kept different dates, the former the American, the latter the Asiatic. To remedy this inconvenience, the Manila authorities arranged that December 30, 1844, should be immediately followed by January 1, 1845, thus adopting the American date for the archipelago.

The purchase of Alaska by the United States had also its effect in straightening the date line, as this territory, which had formerly kept the Asiatic date, from henceforth, of course, adopted that of America. Further progress in the direction of the assimilation of the date line to the 180th meridian must necessarily be slow, as the course of the line is mainly determined by the grouping of the islands, and by the particular circumstances in each group upon which depends the direction in which it has intercourse with the outer world.

A glance at the map which accompanies the paper will show the discrepancies that, at the present time, exist in the position of the date line as laid down by different authorities. The most remarkable divergence is in the case of the line given in Stieler's Hand Atlas. But as the Atlas is dated 1892, this position of the date line may, perhaps, be considered as not being quite up-to-date. The line marked "Wharton" is that of the Hydrographic Office, and was kindly communicated to the author by Admiral Sir W. Wharton; that marked "Smith" is taken from an interesting article in the *Century Magazine* for September of last year, by Mr. Benjamin E. Smith, who, however, does not give his authority for the position of the line; that marked "Davidson" is due to Prof. Davidson of the University of California, and was kindly communicated by Prof. Harkness of Washington.

* 'Travels through the Alps,' chap. vii.

† 'Revue des Deux Mondes,' vol. xvii. p. 924.

‡ Abstract of a paper entitled "Where the Day Changes," recently read to the British Astronomical Association, and which is printed in the *Journal* of that Association, vol. x. No. 4.

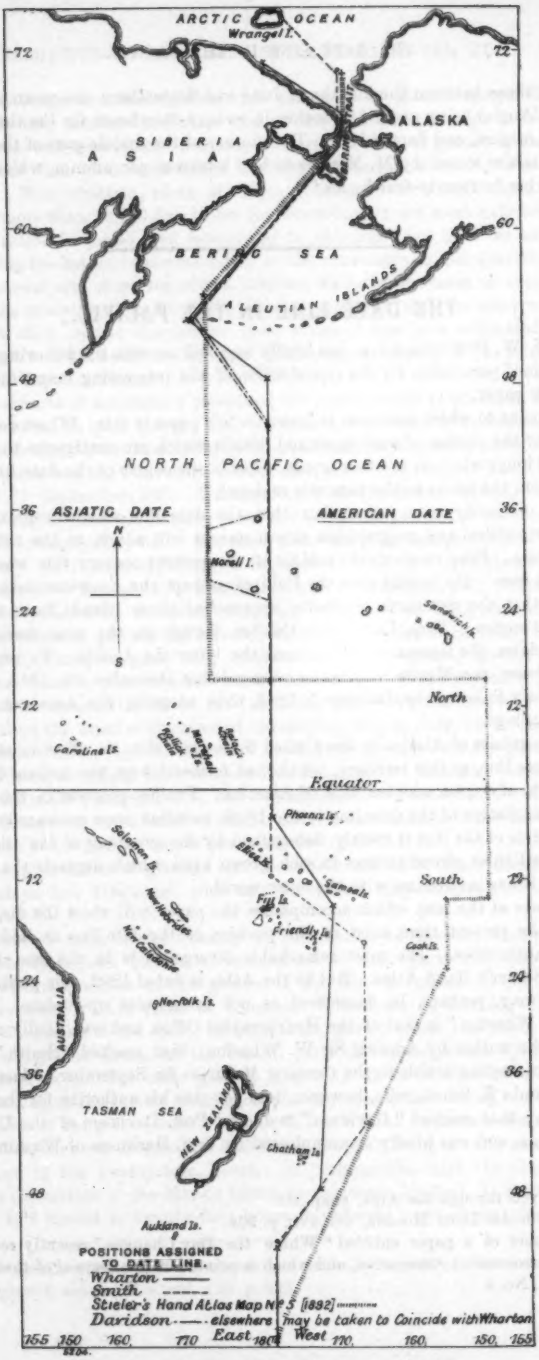


CHART SHOWING DATE LINE IN THE PACIFIC.

It will be noticed that Wharton and Davidson only differ in unessential particulars, affecting one small group of islands. It may, therefore, be concluded with some confidence that we have in these two lines an almost certainly accurate delineation (with the exceptions referred to) of where, at the present time, the day changes.

THE MONTHLY RECORD.

EUROPE.

Dr. Cvijić's Researches in Macedonia.—Prof. Jovan Cvijić continued his researches in Macedonia during the summer months of 1899, and is now engaged in the preparation of a geological map and geomorphological description of the country. He has also paid special attention to an examination of the lakes of Macedonia, the results of which are of much interest. The soundings, over two hundred of which were taken in the larger lakes, show that Lake Ochrida is one of the deepest in Europe, coming tenth in order with a maximum of 286 metres (938 feet). It is thus 34 metres (111 feet) deeper than the Lake of Constance, which has more than double its area, and apart from Loch Morar in Scotland (329 metres, or 1079 feet), a Norwegian lake, and the wide basin of Lake Onega in Russia, is surpassed in depth only by some lakes in the Southern Alps. Lake Prespa, or Presba, is, on the contrary, only 54 metres (177 feet) * deep, and Lake Ostrovo, situated further east on the Monastir-Saloniki railway, 61 metres (200 feet). The smaller lakes are, comparatively, very shallow. Lake Ochrida is fed by a large number of strong springs—in fact, it may be said that its deep basin is entirely filled by spring-water. Its colour is accordingly an extremely pure blue, and the white sounding-lead can be distinguished at a depth of 40 feet. The maximum temperature gradient (*i.e.* the most rapid diminution of temperature in a downward direction) occurs at a surprisingly great depth in all the Macedonian lakes, being found in some almost as much as 25 metres (82 feet) below the surface. Prof. Cvijić proposes to publish bathymetrical maps and profiles of the lakes (the former on the scale of 1 : 100,000) on the model of those in Penck's works on the lakes of Austria, and Dr. Mill's maps of the English lakes.

ASIA.

M. Bonin in North-Western China.—The first number of *La Géographie* (p. 57) contains news of the progress of M. Bonin (*Journal*, vol. xiv. p. 206) down to August, 1899. From Ning-Hsien-fu (Ning-hia ?) he had crossed the Alashan desert by a new route, differing from those of Prjevalsky and Potanin, to Liang-chau in Kansu. The passage of the desert occupied fifteen days, water being met with almost daily, except in the region of dunes known to the Mongols as Tingri iviesu (celestial dunes), which are formed of sand so fine that the least breeze is sufficient to obliterate the tracks. It is therefore necessary to depend solely on the instinct of the camels for the maintenance of the proper direction.

AFRICA.

Moore's Tanganyika Exploration.—Apropos of the communication by Mr. Fergusson on Lake Tanganyika in the present number, a telegram from Sir

* Dr. Oestreich (*ante*, p. 174) was told by the fishermen that the greatest depth was forty times the span of the outstretched arms, the difference being easily accounted for by the probable deviation of their lines from the perpendicular.

Harry Johnston to the Foreign Office has been communicated to the Society stating that Mr. Moore's expedition has safely reached Uganda.

African Trade.—The various consular and colonial reports issued during the past year enable us to obtain a general view of African trade during 1898, the last year for which full returns are available. The great bulk of the trade of the continent belongs still, of course, to the older extra-tropical European possessions, fully 70 per cent. of the total being divided between Cape Colony (with total trade of 42 millions), Natal (6·6 millions), Algeria (22·9 millions), and Egypt (22·8 millions). Next to these come Mauritius (5·8 millions), Portuguese East Africa (4·4 millions, including goods in transit), and Tunis (3·9 millions). Other countries, however, show a steady increase within recent years, though much of this is due to a greatly increased export of rubber, obtained too often by wasteful methods which must lead before long to a reduction in the supply. In certain cases the increase is due to imports for railway construction, etc., and not to normal commerce. Of the tropical dependencies of European countries, Zanzibar comes first with a total of just over three millions; but this is, of course, made up mainly by transit trade to the adjacent coast territories. Senegal, Portuguese East Africa (special trade), and the Congo State all showed totals of over two millions, Angola and the Gold Coast falling very slightly behind; while Lagos, the Niger Coast Protectorate, Réunion, and German East Africa all passed the total of one million. The British colonies continue to do a preponderating proportion of their trade with the mother country, but a falling off of British trade is recorded in several of the foreign possessions, *e.g.* Madagascar (owing to the new tariff), Angola, and the Congo State. With many of the French West African colonies, however, it has shown a marked increase during the past few years, the total volume of British trade with these having more than doubled since 1894, while the import of British cottons has risen since that year from £114,000 to £391,000. Much of the trade of French Guinea and Dahome passed respectively through Sierra Leone and Lagos, but efforts have lately been made to divert the trade from the former to Konakri. In Senegal France maintains a decided ascendency. The trade of the German possessions, as recorded in a recently issued *Weissbuch* (No. 20), shows a general increase, the most promising colony being, perhaps, the Cameroons, where the plantations of cacao supply £15,000 worth of that article for export. The natives are said to show some willingness to work. In the Congo State and Angola, where rubber forms by far the largest article of export, the trade is chiefly in the hands of the Belgians and Portuguese respectively, though the Germans are now obtaining some footing in Angola, and threaten the position of the British. On the East Coast trade is not generally so active, and in Portuguese East Africa especially the exports are small, while the imports are largely swelled by goods in transit to the Transvaal and Mashonaland, and by materials for the Beira railway. The last returns for British East Africa show a slight falling off of trade, while in German East Africa the exports form little more than a quarter of the total.

Proposed new French Expedition across the Sahara.—The impetus lately given to French operations in the Northern Sahara has led to the organization of an expedition, supported by the Paris *Matin*, for the study of a route for the proposed Trans-Sahara railway to Lake Chad. Its leader is to be M. Blanchet, who will be accompanied by a geologist and several engineers. According to *Petermanns Mitteilungen*, in which this announcement is made, the whole of the Sahara between Insalah and Timbuktu—also, according to present plans, to be eventually traversed by a railway—is to be formed into a separate government under the name Mauritania.

Telegraphic System in French West Africa.—In the first number of *La Géographie*, M. Binger gives a useful historical sketch of the development of telegraphic lines in French West Africa, with a sketch-map showing the lines open, constructing, and projected. The writer points out the valuable results towards the establishment of French influence in West Africa which have followed from the methodical extension of the telegraphic system, commenced in 1862 by the first step towards a line from Dakar to St. Louis. The first direct communication between France and Senegal was effected in 1884 by the line connecting the colony with the Canaries. Since that date the lines have been pushed constantly forward towards the interior, which is now better provided in this respect than any other part of tropical Africa. From four starting-points on the coasts of Senegal and French Guinea lines have been carried towards the upper Niger, with various connecting lines between them. All unite before reaching Bamako and Segu, from the latter of which a northern line continues to Timbuktu, while a more southerly one traverses the countries within the bend of the Niger, and ultimately reaches the coast of Dahome. A branch line will soon reach Kong from the north, and may ultimately be continued to join the system of the Ivory Coast, which at present consists of a line parallel with the coast through the whole length of the colony and a short branch towards the interior. Other projected lines are: (1) a connecting line from French Guinea to the western extremity of the Ivory Coast; (2) a line from Bandiagara (to which a branch already runs from the Senegal-Dahome trunk line) to Say on the Niger, with a connecting link thence to the Dahome line.

The Iron Industry in Togoland.—In the fourth number of the *Mitteilungen aus den Deutschen Schutzgebieten* for 1899, F. Hupfeld gives a sketch of the iron-workings at present carried on by the natives in Togoland. Iron ore is everywhere found in the crystalline schists, of which the mountain zone running through the country in a north-easterly and northerly direction is composed. But though traces of former workings are seen in many parts of this zone, the industry is practised at the present day in two districts only—that of Basari and Banyeri in the north, and that of Boem in the centre. The production is greatest in the former, which is a country of isolated hills rather than mountain ranges. The inhabitants speak a language different from that of their neighbours, though said to present analogies with that of the Gurmas further north. They have a hatred of strangers, and are little touched by Mohammedan or European influence, so that the iron industry is with them in its primitive condition. In the Boem district the production is already diminishing owing to the importation of European (principally English) iron. The craft of the blacksmith will, however, continue to be practised, though perhaps subject to modifications. The writer gives full details as to the methods of smelting, etc., employed, with illustrations of the furnaces used in the different districts.

Brazzaville.—A large-scale plan of the French station of Brazzaville is given in the *Dépêche Coloniale* for February 18–19, accompanied by a sketch of the development and prospects of the place by Emile Lenoir. The plan shows the quarters reserved for the present and future Government buildings, and the concessions hitherto secured by various commercial companies, the whole extending, with some intervals, for a distance of 2½ miles along the shores of Stanley pool. M. Lenoir lays stress on the exceptional advantages presented by the site, which will make it, he thinks, one of the most important African centres in the future, possibly receiving the commerce even of Adamaua and the region of Lake Chad. Its great need is that of a railway to the coast, though a great development is already noticeable since the opening of the Belgian railway. It is already provided with telegraphic communication with the coast.

Region of Maximum Rainfall in West Africa.—A record of the rainfall at Debunja, a plantation on the western flanks of the Cameroons, which has been kept regularly since 1895, shows that that locality is not only the rainiest in all Africa (so far as can be affirmed in the present state of our knowledge), but the second rainiest district on the globe. The excessive rain of 1895 was thought to possibly indicate that the year was an abnormal one, but subsequent observations prove that this was not the case, the rainfall of each of the succeeding years having slightly exceeded the total for 1895. The results of the observations for 1898, with a comparison with the total of the three preceding years, are given in the *Mitteilungen aus den Deutschen Schutzgebieten* for 1899, the mean for the four years being 9462 mm. or 372·5 inches, as compared with a fall of 475 inches at Cherrapunji. Records from a second station on the west of the mountain, extending with some breaks from the end of 1895 to September, 1899, are published in the first number of *Petermanns Mitteilungen* for the present year. They show that the rainfall here agrees closely with that at Debunja, the annual mean being 9344 mm. or 367·9 inches. The months from June to October show the largest totals, and December and January the least. An amount of 12 inches has more than once been recorded in a single night. Such excessive rainfall seems to be limited to a small area, records from other stations in the territory showing a much smaller amount. At the government station on the Cameroons river the mean of the five years 1894–98 shows an annual fall of 158 inches only.

Disaster to Dr. Pleyn's Expedition in the Cameroons.—We have already referred (*Journal*, vol. xiv. p. 444) to Dr. Pleyn's exploration in the south-west corner of the Cameroons territory, to which he went, by way of the Congo, for the purpose of furthering its economic development. It is now announced (*Pet. Mitt.*, 1900, p. 48) that while attempting to open direct communication with the Yaunde station in the centre of the territory, Dr. Pleyn lost his life from a poisoned arrow on November 24 last, during an attack by the Busa tribe. The deceased traveller was apparently Dr. F. Pleyn, who in 1898 published a work on the climatology and hygiene of the Cameroons, as he is spoken of as a forest officer, while Dr. A. Pleyn, who has also done scientific work in the territory, belongs to the medical service.

Meteorology of Tropical Africa.—The eighth report of the British Association Committee on the climatology of Africa, drawn up by Mr. Ravenstein, is published in the recently issued general report of the association for 1899. The number of stations from which returns have been received reaches the high total of forty as compared with twenty-six during the previous year. The most valuable work has perhaps been done in Nyasaland, where the meteorological service has been organized by Mr. J. McClounie, head of the scientific department. We are glad to see that the very complete series of observations inaugurated by Mr. John Moir at Lauderdale in 1894, of which only two years' results had been previously published, has been continued without a break, being now brought down to 1898 by the publication of three additional years' records. During Mr. Moir's absence in 1896 the observations were made by Mr. Thomson. The series now bears comparison with those obtained by the Germans at the Cameroons and elsewhere, and the hours of observation (6 a.m., 2 p.m., and 9 p.m.) agree with those adopted by the latter, except the first, which is an hour earlier at Lauderdale. At the new stations at Zomba and Fort Johnston the first observation is made, as by the Germans, at 7 a.m. At Mombasa a continuous record (though not so detailed) has been kept by Messrs. Pigott and Craufurd since 1894, but the full observations begun in 1896 by the Scotch missionaries at Kibwezi, have been interrupted by the removal of the mission from that station. They are being continued, however,

at the new station in Kikuyu. A record has been kept by Mr. Ormerod of the level of the Tana river at Golbanti, which shows that the floods reflect two rainy seasons, which are not those of the lower river, but of the country at its source near Mount Kenya. The Tana is therefore a miniature Nile, and offers great potentialities for irrigation.

Geological Features of German Nyasaland.—At a meeting of the Berlin Geographical Society in December last, Herr W. Bornhardt gave an instructive paper on the "Geography and Geology of German Nyasaland," a report of which appears in the last number of the *Verhandlungen* for 1899. Herr Bornhardt has been principally known for his discovery of workable deposits of coal in the basins of the Songwe and Kivira rivers (*Journal*, vol. xiii. p. 73), but his extensive journeys in the country north and east of Nyasa have given him good opportunities of becoming acquainted with the general structure of the land. Regarding the lake itself, he has no hesitation in ascribing its formation to the subsidence of a segment of the Earth's crust, though it will be remembered that Mr. J. E. Moore throws doubt upon this explanation of the origin of the lake as a whole. Herr Bornhardt—who, among other evidences of subsidence, points to the great depth of the lake—considers that the line of depression is prolonged north of Nyasa, in which direction it forks into two branches, the one passing north-west to Lake Rukwa, the other, due to diagonal faulting, embracing the wide Ruaha valley, bounded on the west and south by well-marked fault-scarps. The falling in of the floor of the trough is intimately connected with a welling up of volcanic material, which, just at the diverging point of the two northern branches, in some measure break their continuity with the main trough. The highlands around the north end of the lake are divided into three sections by the rift-valleys. The northern mass, which in Mount Beya reaches a height of 9700 feet, seems to be composed entirely of gneiss. The western highlands occasionally present, in their northern parts, the character of a tableland, due apparently to deposits of sandstone of "Karroo" age. Sandstones occur also at a lower level on the border of the highlands, and in these the coal deposits are found. Further south gneiss again appears. The eastern highlands are divided into two sections by the deep valley of the Ruhuhu, the largest feeder of the lake, the only gap through which it might be possible to bring a railway from the coast to Nyasa. Sandstone again occurs here, and with it coal, but not of any value. North of the gap runs a zone of gneiss, forming the longitudinal ridges and valleys of the Livingstone or Kinga range; the ridge nearest to the lake falling abruptly to the water from a height of 6000 feet above it. The writer contends that these highlands well merit the name of a range, as they fall considerably to the east as well as to the west. Further north they widen out, but maintain their mountainous character. They are broken towards the east by the wide hollow of Buanyi, bordered by table-like masses composed in their upper parts of horizontal quartzites, sandstones, and conglomerates, which are probably of older date than the sandstones of the Songwe and Ruhuhu. They rest on tilted beds of ancient crystalline schists, which characterize the eastern parts of the highlands, though narrowing down towards the south. On the eastern margin the surface consists chiefly of a thick deposit of sandy loam, which seems to have been derived from denudation of the Kinga range when at a greater elevation than at present. The uplands are for the most part covered with rich grasses, and parts of the region might be suitable for plantations under European supervision, but there is little prospect of success for small farmers. South of the Ruhuhu the highlands consist of two *massifs*, gneiss in the north and granite in the south, separated from the lake by a strip of lower but much broken country. Herr Bornhardt concludes by describing the rich alluvial plain of Konde with the volcanic masses to the

north, culminating in Mount Rungwe (10,400 feet), the highest point of the whole country. This district is the most promising of all Nyasaland.

AMERICA.

Alaskan Surveys during 1899.—A short *résumé* of the survey work accomplished last year in Alaska by parties from the U.S. Geological and Coast and Geodetic Surveys, is given in the fifth number for that year of the *Bulletin of the American Geographical Society* (p. 503). One expedition of the Geological Survey, under Messrs. W. J. Peters and Alfred Brooks, was successful in fixing the position of the headwaters of the Copper, Tanana, and Nebesna rivers, a reconnaissance map of most of the route being constructed. The proposed additional work in the direction of Birch creek and the Myncok district was of necessity abandoned. A second party, consisting of Messrs. F. C. Schrader and T. G. Gerdine, made its way by rail and steamer *viâ* the White pass and the Yukon river to Fort Yukon, thence ascending the tortuous Gens de Large river in canoes. A new part of its course was mapped, and the Kuyukuk having been reached by a portage, that river was descended to the Yukon, topographical and geological reconnaissances of the whole route being made. Subsequently, having reached the coast by steamer, Mr. Schrader, joining Mr. Brooks, mapped a strip of the coast near Cape Nome. The beach diggings were found to extend for 16 to 18 miles between high water and the tundra, the gold occurring in streaks of very fine grains. During the summer the examination of the Yukon delta was completed by Messrs. Pratt, Putnam, and Faris of the Coast and Geodetic Survey. It had been hoped that a deeper entrance to the Yukon than that generally used might be found, but in this the party was unsuccessful. The coast-line was found to extend from 10 to 15 miles further out than had been supposed. The water is exceedingly shallow, miles of mud-flat being exposed by certain combinations of wind and tide. While canoeing round the whole delta, Dr. Edmunds had to go out of sight of land or to drag his canoe through miles of mud. Scammon bay, south of the Yukon, was found to be useless as a port in lieu of St. Michael's, but a good harbour for light-draught vessels was found between Cape Nome and Golofnin bay. Finally, an excellent collection of small mammals and birds was made during a boat voyage down the Yukon by a party sent out by the Biological Survey, consisting of Messrs. Osgood, Maddren, and Bishop. The work of the party supplements that of the Harriman expedition (*ante*, p. 66).

The Idaho and Montana Boundary-line.—The United States Geological Survey has completed the survey and marking of that portion of the boundary-line between Idaho and Montana running north from the Bitter Root mountains to the international boundary, corresponding to the 39th meridian west from Washington, or 116° 3′ 2·30″ west from Greenwich. The remaining portion of the line follows the crest of the Bitter Root and Rocky mountains. An article giving particulars of the work, by Mr. R. U. Goode, appears in the January number of the *National Geographic Magazine*. The line going northward starts at an elevation of about 4850 feet, and, descending from the summit of the Bitter Root mountains, crosses the Clark fork of the Columbia at an altitude of about 2220 feet, and reaches the summit of the Cabinet mountains at an elevation of 6670 feet. It next intersects many canyons tributary to the Kootenai river, and crosses the latter, touching the platform of the station-house at Leonia on the Great Northern Railroad, at an elevation of 1824 feet; thence it ascends the Yak mountain, reaching an altitude of 6585 feet, whence there is a gradual descent to the international boundary, at which point the elevation is about 4500 feet. The length of the line surveyed passes through a latitudinal interval of 1° 1′ 24·65″, or about 70½ miles.

New Matter bearing on Humboldt's Travels.—A series of papers and letters by Alexander von Humboldt, published for the first time in the *Zeitschrift* of the Berlin Geographical Society (1899, pt. 4), throws new light on the events connected with the traveller's preparations for his great journey to South America. It has been generally believed that the merit of opening the way for that undertaking belonged exclusively to Baron von Forell, ambassador at the court of Madrid from the King of Saxony; but materials have hitherto been too scanty to admit of a full knowledge of the course of events which preceded the departure on the voyage. The want has now been supplied by the discovery of the papers above referred to, most of which consist of letters addressed by Humboldt to Baron von Forell in 1799 and 1800. Having come into the hands of Karl von Forell, the last representative of the family, they were bequeathed by him to the Swiss historian Alexander Daguet, among whose papers they were found by his grandson Pierre Favarger. They have lately been secured by the Berlin Geographical Society, and placed for publication in the hands of Herr E. Lentz, who in an introductory notice explains fully their bearing on the history of the voyage. It appears from the letters that in the negotiations respecting permission to travel in the Spanish colonies, three men bore a principal part—Von Forell, the Spanish minister Urquijo, and the Prussian secretary of legation Von Tribolet. It has been stated by Humboldt's biographer, Bruhns, that no interest in Humboldt's plan was evinced by the Prussian envoy, Count von Rohde. This is easily accounted for by the fact that the count was not at Madrid during 1799, while the now-published material shows that the secretary, Von Trilobet, who managed the business of the embassy in his absence, was on most intimate terms with Humboldt. The Spanish minister was also personally well disposed to the traveller. The documents, which include a statement by Humboldt of his previous scientific labours and a memorandum on the points which he wished touched upon in his passport, show how much of the initiative was due to the traveller himself, and also set forth clearly the relative positions of the two members of the expedition. The memorandum just alluded to is interesting as indicating the ideas which Humboldt entertained as to the route to be followed and other details of his plans. The letters to Von Forell both give an additional insight into the character of the traveller, and also supply details as to his scientific labours during the early part of the journey.

Dr. Hermann Meyer's Second Expedition to the Xingu.—A note in the *Geographische Zeitschrift* (1900, p. 117) gives a short account of Dr. Hermann Meyer's second expedition to the headstreams of the Xingu (*Journal*, vol. xiv. p. 324), from which the traveller has lately returned to Leipzig. The expedition—which included, in addition to Dr. Meyer, Drs. Koch (Giessen), Mannsfeldt (Dresden), and Pilger (Berlin), as well as seven German colonists from Rio Grande do Sul, and a number of Brazilians, negroes, and Indians—assembled early in 1899 at Cuyaba, whence a start was made across the plateau to the north towards the Rio Formoso, apparently a main branch of the Ronuro. The descent of this river, which commenced in eleven canoes in May, 1899, involved serious difficulties, owing to the rapids in its course and the uninhabited character of its banks. Many canoes and effects were lost, while sickness broke out among the members of the party. One of the many falls of the Ronuro, "Bastian fall," has a drop of over 60 feet. In this part of the river absolutely no fish were found, so that the food-supply presented great difficulties. Finally the mouth of the Kuluene was reached, whereupon the expedition entered that stream and visited the various Indian tribes encountered by Dr. Meyer on his first journey. Extensive ethnographical collections having been made, Cuyaba was again reached early in October. Dr. Pilger, who had separated from the rest of the party on arrival at the Ronuro,

obtained a large number of botanical specimens, forming the largest collection yet made in the interior of South America.

Geographical Features of Southern Patagonia.—Prof. J. B. Hatcher, whose recent return from lengthened explorations in Patagonia was referred to in our last number, contributes to the February number of the *National Geographical Magazine* a concise description of the main features of the country visited by him, with a discussion of their mode of origin. Beginning from the line of sea-cliffs, consisting of alternate layers of sandstones and clays, which form the eastern limit of Patagonia, he describes in turn the elevated barren plains rising from the coast in a succession of steps, furrowed by deep transverse valleys, and covered in the central parts by rugged lava-fields; the more fertile zone, covered in great part by glacial deposits, which skirts the Andes on the east; and the three parallel chains of the Andes themselves, separated by two deep longitudinal valleys. The most striking phenomenon is the anomalous position of the continent water-parting to which the principal difficulties in the settlement of the Chilean-Argentine boundary question is due. Prof. Hatcher, who goes somewhat fully into the question, differs from Dr. Moreno in his explanation of the unusual drainage conditions. An examination of the low continental divides, to the east of the line of lakes which Dr. Moreno considers to have been formerly drained to the Atlantic, showed that the original rocks are not covered to any considerable depth by glacial detritus, such as might have dammed back the outlets of the lakes. Prof. Hatcher attributes the present conditions entirely to the movements of elevation and subsidence which have prevailed in recent geologic epochs, and points to the state of things in the extreme south, where the movement of elevation has been less marked than in the north, as representing a former stage in the geographical evolution of other parts of Patagonia. In his opinion, the longitudinal valleys of the Andes and the transverse valleys which cross the whole country, had their origin previous to the last submergence, which occurred during a relatively short period in late Pliocene times. This submergence was greater over the western than over the Eastern Andes, thus rendering the western channels deeper than the eastern. During the first stage of subsequent elevation, the valleys would remain submerged, the transverse ones forming straits connecting the two oceans. In the second stage they would appear as land valleys, while the western longitudinal valley would form a continuous channel sending a series of fiords into the eastern one. In the third, the connection between the two longitudinal valleys would be broken, the eastern one being occupied, as at the present day north of Lake Argentina, by a series of lakes discharging westwards. A fourth stage, in which the bottom of the western valley is brought above water-level, is observable in the extreme north.

AUSTRALASIA AND OCEANIC ISLANDS.

A Newly-Discovered Cave in New South Wales.—In his reports on the limestone caves of New South Wales for 1898, embodied in the Annual Report of the Department of Mines and Agriculture of the Colony for the same year, Mr. O. Trickett describes a newly-discovered cave at Wombeyan, celebrated for its extensive decorations. The "Junction Cave," as this new cave is called, is situated near the junction of the Wombeyan and Mares Forest creeks. Its length between the extreme points is about 10 chains in a direct line, while its explored passages are said to total about three times that length. There are two entrances. The lower one is about 60 feet from the Wombeyan creek, and about 20 feet above the level of the creek. From this entrance a narrow and tortuous passage, with many ripple-marked terraces, leads to the centre of the cave. The upper entrance is about 130 feet above the creek, from which it is distant about 170 feet. The cave

is traversed by a number of passages, notably by two running north and south. The northern one of these is of particular interest, being embellished with many beautiful pillar and "shawl" formations and cream-coloured crystalline deposits. At a certain point the present underground waterway is visible. Southward the passage is notable for its draped and terraced crystalline "cascades," ornamented grottos and stalactites. It opens out into a large dry cavern, 116 feet long, and appears to be 70 feet high in one place. The report is illustrated with a plan and sections.

Points of Nomenclature in the Western Pacific.—In the first number of the *Verhandlungen* of the Berlin Geographical Society for 1900, Herr F. Strauch calls attention to one or two points respecting the nomenclature of places in the German sphere in the Western Pacific. The first refers to the Admiralty group, to the largest island of which no individual name is generally applied, the term great Admiralty island being used in our maps for want of a better. No native name seems to be in use, inquiries during a recent visit by the commander of the *Möwe* having been unsuccessful in eliciting any. Herr Strauch, however, points out that a name exists which meets the requirements laid down at the Seventh International Geographical Congress for cases where native names are wanting. The island, to which Schouten's map merely applies the general description "hoch landt," was sighted on January 10, 1781, by Maurelle, commander of the Spanish frigate *Princesa*, who gave it the name "Don José Basco," in honour of the then governor of the Philippines, and the name seems to have the right of priority, as neither Schouten nor Carteret bestowed any. It is wrongly written "Bosco," both by Meinicke and in the *Challenger* Report ('Narrative,' vol. i. part ii. p. 697). Referring to an allusion by Count Pfeil in his recent work to the first settlement of Port Hunter, on Duke of York island, Herr Strauch points out that the name is derived from Captain John Hunter, who accompanied Governor Philipp to Botany bay in 1788, and visited the island in 1791, and not from the captain of the Wesleyan Missionary Society's ship, which first visited the port in 1875. The name Port Hunter was used by D'Urville in 1833. Among the many instances of confusion arising from ill-judged changes of names, Herr Strauch mentions that Blanche bay, named after the British corvette of that name, has been by some altered to "Weisse Bai," though the proper name is retained in the best German maps.

The "Albatross" Expedition to the Pacific.—A third letter from Dr. Agassiz regarding the work of the *Albatross* expedition, dated Suva harbour, Fiji islands, December 11, 1899, is published in *Science* of February 23, as also in the *American Journal of Science* for March. On the way to Suva a few soundings were made between Tahiti and Tonga, the depths ranged from 2472 to 2882 fathoms, the bottom being red clay. A trawl haul was made about 75 miles to the eastward of Tonga-Tabu, in a depth of 4173 fathoms. In the proximity of the 4762-fathom sounding marked on the chart, a depth of 4540 fathoms was obtained. The soundings taken in the vicinity of the Fiji islands seem to indicate a continuous plateau of moderate depths from Wailangolala south, upon which the islands of the Lan group rise. An account of the structure of the Leeward Society islands is given. Aitutaki, in the Cook group, was found to be volcanic. Niue is described as composed of elevated coralliferous limestone showing three well-marked terraces, which in many cases are disappearing completely. The main portion of the letter deals with the Tonga group, and details of their topography and structure are given. In conclusion, the writer states "that in the Tonga group, which is a very extensive area of elevation, the recent corals have played no part in the formation of the masses of land and of the plateaus of the Tonga ridge, and

that here again, as in the Society islands and Cook islands, both also in areas of elevation, they are a mere thin living shell or crust growing at their characteristic depths upon platforms which in the one case are volcanic, in the other calcareous, the formation of which has been independent of their growth." The Ellice, Gilbert, and Marshall islands will probably be visited next.

Depths in the North Pacific.—The Washington correspondent of the *New York Sun* of February 25, states that Lieut.-Commander H. M. Hodges, of the U.S. surveying ship *Nero*, has discovered a submarine depression of great depth in trying to find a southern route to connect Guam with the proposed cable from Honolulu to the Midway islands. In this depression, which has been named Nero Deep, two remarkable soundings were obtained, one of 5160 fathoms, and the other of 5269 fathoms. This is about 100 fathoms deeper than the soundings made by H.M.S. *Penguin* in the South Pacific, and appears to be the deepest sounding ever made in any ocean. The deepest temperature-readings obtained were 35°·9 at 5070, and 36° at 5101 fathoms. A line drawn from Guam to Midway island on the bathymetrical map published in the *Challenger* Narrative crosses the southern extremity of the Tuscarora Deep; but as bottom temperatures of 35° or 34°·9 were obtained in that depression, it would appear that the new soundings do not form part of it, but indicate a separate hollow, the walls of which rise nearer to the surface than do those of the Tuscarora Deep. Pending the publication of the official report, however, nothing definite can be said except that in this as in other cases of recent deep-sea soundings the depth of the ocean is shown to be greater than was formerly supposed.

MATHEMATICAL AND PHYSICAL GEOGRAPHY.

Climate and Industry.—A paper on the climatic distribution of industry, read by Dr. Ernst von Halle at the Berlin meeting of the International Geographical Congress, is printed in the first number of the *Geographische Zeitschrift* for 1900. The writer begins by referring to the economic laws which have been laid down in the past as determining the action of climate on industry, and which have been appealed to by the champions both of slavery as a necessary institution, and of free trade; afterwards pointing out the tendency of modern scientific progress to disturb formerly accepted conclusions. The conditions of production, as well as of transport, have been so changed, above all by the use of steam, that new solutions of the problem as regards both its geographical and economic aspects must be sought. In adopting the theory that the raw products of the whole world must be brought for manufacture to certain centralized points, former speculators attributed too much weight to climatic factors, and the effect of these both on the possibilities of production and on the conditions of human life are now seen to have undergone a change. The effects of both heat and moisture can now be combated by artificial means, while the present facilities for rapid transport, and improved sanitary and other conditions of life, make it possible for the northern races to carry on industrial undertakings in hot regions where such were formerly considered impossible, as, *e.g.*, in the Southern United States, South America, Mexico, and the West Indies, as well as India and China. The comparative independence of climatic conditions is seen, too, in the far north, in the goldfields of Alaska, and in Russian industrial undertakings on the borders of the polar regions. The extensive employment of Italians and others in America, and of Chinese and Indian coolies in various parts of the world, is pointed to as favouring the industrial development of the tropics, which in many ways are held to possess advantages over the temperate zone. The mental capacity necessary for the initiation of such progress seems, however, to be found only in the latter. The writer concludes by pointing out that the successful

states of the future will be those which have secured a supply, from their own territory, of the products of all climatic zones.

An Equal-area Projection for Equatorial Maps.—Ten years ago an article appeared in *Petermanns Mitteilungen* by Herr Nell, on an improved form of conical projection, which, while retaining the advantage of equality of areas, avoided to some extent the distortion arising from the oblique angle at which the meridians cut the parallels at a distance from the centre of the map. The subject is again taken up in the same periodical (1900, pt. 2) by Dr. E. Hammer, who discusses fully the formulæ to be used for such a projection, with special reference to the limiting case when the equator is the central parallel of the map. The writer points out the disadvantage of the modified cylindrical projection, usually known as that of Sanson, or Flamsteed, which is so persistently retained for maps of the equatorial regions, such as Africa or the Pacific islands, and considers that, as it seems impossible to banish this altogether, an improvement in its form would be of some importance. To this end the ordinates are so chosen as to lie midway between those of Lambert's and Sanson's projections, thus avoiding, as far as possible, the disadvantages of both. Dr. Hammer first finds the expressions for the co-ordinates in the case of a cone, and then applies the corrections necessary to suit them to that of an ellipsoid, obtaining by this means a table of co-ordinates, at intervals of 5°, for a map extending 40° from the equator. The values for the 5° intervals of latitude, given in kilometres, vary from 552 (between 0° and 5°) to 490 (between 35° and 40°), while the same interval of longitude is represented at the equator by 556·5, and at 40° by 491·2. Beyond 20° the intervals between the parallels are somewhat less curtailed than was the case by Herr Nell's method, so that the meridians are very slightly more in agreement with those of Sanson's projection. As regards the obliquity of the angles at which the parallels and meridians intersect, Dr. Hammer gives a table showing the values according to the three systems under discussion. At 40° from the equator and 40° from the central meridian the deviation from a right angle amounts, according to the new method, to 20° 34′, as compared with 25° 18′ and 30° 11′ by Sanson's and Lambert's methods respectively.* Dr. Hammer considers this not a very decided improvement in itself, but thinks that the adoption of the new method might lead the way to better methods of delineation for the equatorial regions generally. He concludes his article by pointing out a simple method of avoiding the inaccuracy resulting from the common practice of disregarding the difference between the length of chords and arcs in setting off the intervals of longitude.

Subterranean Explorations by M. Martel in 1899.—An interesting *résumé* of the work accomplished during 1899 by the indefatigable speleologist M. Martel appears in the first number of *La Géographie*. M. Martel began the campaign in May, in the Jura, which has been examined since 1896 by MM. Fournier and Magnin, and which, he says, promises to rival the regions of the Karst and of the Causses as a field for underground exploration. Unexpected results as regards the mutual relations of sources and abysses were yielded by the barometric and thermometric observations, while on sounding for the first time the famous rock-pool of Creux Billard, near Salins, a depth of almost 70 feet was revealed, the bottom of the channel by which it is drained being below the level of the neighbouring valley. In the *massif* of the Vercors, M. Martel visited, among others, the grottos of Bournillon and of the Brudoux, both excellent examples of subterranean hydrology. The latter was explored for 380 yards beyond the

* For a limited zone in the vicinity of the equator, Lambert's projection gives the smallest divergence.

furthest point previously reached. Thermometric observations proved that the stream issuing from the Goulenoire is not, as had been supposed, derived from the Bourne, but must have an elevated origin. In the *massif* of the Dévoluy (Hautes Alpes) the most important work was the exploration of a pot-hole named by M. Martel, after his conductor, the Chourun Martin. It revealed the fact that the abyss reaches the total depth of at least 310 metres (1020 feet), composed of four separate shafts, while the explorers imagined they heard the fall of rocks down a fifth. The depth just mentioned makes the abyss the deepest natural one known, that of Trebitsch, in Istria (321 metres), being in part artificial. At the lowest point reached it was about 400 metres (1300 feet) above the Source des Gillardes, the general outlet for the subterranean waters of the district. In the Chourun de la Parza, M. Martel found *névé*, crevassed like a glacier, at the depth of 30 metres (98½ feet), the deepest crevasse giving an additional depth of 44 metres (144 feet). M. Martel subsequently examined several of the subterranean passages of Vaucluse and the Causses. In the latter he found the tunnel of Bramabiau completely dry, a very rare occurrence. He was able to verify the fact that considerable modifications, due to erosion, have taken place since his former visits. The depth of the Armand pot-hole was remeasured by the aid of two barometers, and the original determination (207 metres, or 679 feet) proved correct, owing to the mutual compensation of two opposite errors. The bottom of the Gouffre de Padirac was found filled with snow, by which the temperature of the underground stream is lowered 14°–15° Fahr. below the normal. Some new exploration was accomplished, but the complete examination of the cavern will require a dry season, many appliances, and much endurance on the part of its explorers. M. Martel insists on the necessity of preventing the pollution of the underground waters by the common practice of throwing the carcases of animals down the pot-holes.

Hydrographic Surveys in Iceland and the Færoes.—M. Rabot communicates to *La Géographie* (No. 1) some details of recent marine surveys on the coasts of Iceland, etc., taken from the *Geografisk Tidskrift*. The surveys were made by MM. Holm and Hammer in the Danish guard-ship *Diana*, and in spite of the constant fogs, which last summer allowed work during nine days only, all the fjords of Eastern Iceland, from Langanæs to Berufjord, were examined, while the configuration of the sea-bottom was also determined by soundings. The east coast is skirted for a breadth of 50 to 60 miles by banks, giving the sea a depth of under 100 Danish fathoms (620 feet), except where they are traversed by submarine ravines. The results of the surveys ought, it is said, to be of practical service to the fisheries, the banks alluded to being much frequented by cod. Those in the neighbourhood of the Færoes were also examined, and this work will be continued during the present year.

GENERAL.

Geographical Association.—The annual meeting was held at the Imperial Institute in connection with the English Education Exhibition on January 8, and, in the absence of the President, the chair was taken by Dr. H. R. Mill. The Annual Report shows that the Association is growing, slowly and steadily, both in numbers and in influence. It was announced that Mr. B. Bentham Dickinson (Rugby) had signified his intention of retiring from the office of hon. secretary, which he had held since the foundation of the Association in 1893, and a cordial vote of thanks to him for his services was carried unanimously. Mr. Dickinson was not only the founder of the Association, but for the last seven years he has ungrudgingly devoted time and labour to its development. The Association's collection of lantern-slides (maps, diagrams, and views), which now numbers more

than 1500, is entirely his work. By his personal influence and enthusiastic belief in the educational value of geography as a school subject, he succeeded in inducing members of the staff in nearly all the great schools in the country to join the Association, and the committee are glad to know that they can still count on his assistance and advice as one of their body, and that in Dr. A. J. Herbertson (assistant to the Reader in Geography at Oxford) he will have a worthy successor. The President, Mr. Douglas W. Freshfield, treasurer, and other members of the committee were re-elected, with the exception of the Rev. Dr. Gibbins (Kidderminster), who had tendered his resignation. Dr. R. D. Roberts (Cambridge) was elected in his place; and with the addition of Mr. T. G. Rooper (Southampton), already nominated in November, the committee was brought to its full number of twelve, exclusive of the officers. On the motion of Dr. Herbertson, it was decided "That the Geographical Association shall be open to *all* teachers of the geography and other persons interested in the teaching of geography." The effect of this will be to enable teachers in *Primary* schools to become members of the Association, which has hitherto been confined to teachers in secondary and higher schools and colleges. At a meeting of the committee held in February, a comprehensive programme of work for the current year was drawn up. This is now in print, and the hon. secretary or treasurer will be happy to send a copy to any one who wishes for further information regarding the aims and methods of the Association.

Geography at the Australian Association for the Advancement of Science.—The reports of the recent meeting of the Australian Association for the Advancement of Science, published in the *Melbourne Age* and *Herald* (January 10–16), include abstracts of two or three papers of geographical interest. In one of these Mr. J. A. Panton summed up the various indications which have accumulated in the course of time as to the fate of Leichardt's lost expedition, and sketched the probable course of events connected with its last stages. Mr. Panton considered it proved that the whole party had passed the point in the Macdonald range where the tree was eventually found marked with the letter L. Thence, after unsuccessful attempts to advance westward, the survivors probably went north, some of them, but not the leader, reaching Elsey creek by way of Emily spring and Sturt creek. Afterwards going east in the endeavour to reach Queensland, they were captured and detained by natives of the Simmen river. The question of an artificially watered stock route through Central Australia was discussed by Mr. W. H. Tietkens, who pointed out the various advantages which would result from the establishment of such a route. The line suggested would lead from east to west in about 25° 40′ S., taking advantage of the favourable conditions offered by the Mann, Tomkinson, and Cavenagh ranges, which extend for 400 miles. Among the points at which a large extension of the present water-supply would be required, none would be of more importance than Alexander springs, 100 miles west of Warburton ranges, lying as it does on the threshold of a waterless tract of perhaps 200 miles. The results of a number of temperature and density observations in the seas round Australia were communicated by Mr. T. W. Fowler, who stated that during the past two years there has been a considerable decrease in the density of the waters about the Australian coasts, coupled with a lower summer temperature of the sea-water in Bass strait, which pointed to an increased drift of antarctic water northwards.

OBITUARY.

Admiral Somerset.

Leveson E. H. Somerset was the second son of Lord Granville Somerset. He was born in 1829, and was educated at Cheam and at Westminster School, where he showed remarkable proficiency. He was in the sixth form before he entered the navy. Leveson Somerset became a gunnery lieutenant, and served in both Baltic campaigns. He landed with the naval brigade at the capture of Bomarsund in 1854. He also commanded a rocket boat during the night attack on Sveaborg in 1855. He was superintendent of Bermuda Dockyard 1875–78, aide-de-camp to the Queen, and, as Rear Admiral, was second in command of the Channel Fleet 1880–81. Admiral Somerset joined the Society in 1862. He took great interest in geographical work, and when he first became a Fellow, he was a frequent attendant at our meetings. Since his retirement he has led a most useful life, and his loss will be much felt.

Dr. Friedrich Jagor.

The death occurred in February of the well-known scientist Dr. F. Jagor, whose works on the Philippines and other parts of the Malay region attracted considerable notice a quarter of a century ago. A short account of the traveller given in *Globus* (vol. 77, p. 152) states that he was the son of an hotel proprietor in Berlin, who came from Russia at the beginning of the nineteenth century. During a visit to Paris he acquired such a taste for ethnology, that, instead of following in his father's steps, he devoted himself to travel, the extensive ethnological collections which he made being for the most part deposited in the Berlin Ethnological Museum, with which he was officially connected of late years. His best-known work—that on the Philippines—was translated both into English and Spanish. Jagor was never married, but lived the quiet life of a savant. At the time of his death, which resulted from an attack of influenza, he had reached the advanced age of eighty-three years.

CORRESPONDENCE.

Fish in Frozen Rivers and Lakes.

In the *Geographical Journal* for March, p. 256, General Strachey discusses the question as to what becomes of the fish in the streams running into the Mansarowar lake in Tibet. He seems inclined to think that they go down to the lake and thus escape being frozen, or that the supply is received from the lake every summer, these small streams being towards autumn merely a series of detached pools from which the fish could not escape.

The same question occurred to me with regard to the streams running into the Pangong lake at its western end about 15,000 feet above the sea-level; but in that case the fish must, I think, be frozen up and survive the process. The lake is, I believe, too salt (1300 parts of salt in 100,000 of water, 600 parts being sulphate of soda) for fish to live in it; in fact, I could find no animal life except a small crustacean (probably a Gammarus). The stream entering the lake from the north was only about a foot or two deep and a few feet wide. In July 1870, it was swarming with

three or four species of fish, to such an extent that in an hour or two I caught nearly a hundredweight of them, varying from 3 to 8 inches in length. In October this stream was entirely frozen, and would remain so for many months; the temperature of the air on October 8 at sunrise was 15° Fahr., and next day 13° Fahr. It would be interesting to know if any and what fish can be frozen with impunity. I have only been able to hear of one case. Mr. Kappel, librarian of the Linnæan Society, tells me that the late Dr. Day brought to the Society's room a large trout frozen up in ice. It was thawed out, and at first appeared to be dead, but after a few minutes it jumped about the table and seemed to be as lively as if fresh from the river. Only Mr. Kappel and Dr. Murie were present with Dr. Day.

GEO. HENDERSON.
Surgeon-Major.

MEETINGS OF THE ROYAL GEOGRAPHICAL SOCIETY, SESSION 1899–1900.

Sixth Ordinary Meeting, February 19, 1900.—Admiral Sir W. J. L. WHARTON, K.C.B., F.R.S., Vice-President, in the Chair.

ELECTIONS.—*Percy Edward Amy; Captain Frederick John Choles; Rev. John George Gibson; George Grey; J. Williamson Johnston; Thomas Cardwin Lamb; Frederick Clare Lees, B.A.; Rev. William Martin-Ellis, M.A.; Julian M. Vernon Money-Kent (A.M. Inst. C.E.); Martin Hubert Foquet Sutton; Reuben Henry Williams; William Hunter Workman, M.A. (Yale), M.D. (Harvard).*

The Paper read was:—
"Journeys in the Chinese Shan States." By F. W. Carey.

Seventh Ordinary Meeting, March 5, 1900.—Sir CLEMENTS MARKHAM, K.C.B., President, in the Chair.

ELECTIONS.—*A. J. Drexel Biddle; William Louis Bunting; John Richard Higson, B.A.; Alan Bourchier Lethbridge; Christopher Mudd; Edward Penton, B.A.; Captain Ernest Rose, R.H.G.; William Stansfield Torbitt, B.A.*

The Paper read was:—
"In the Heart of Borneo." By Charles Hose.

Eighth Ordinary Meeting, March 19, 1900.—Sir CLEMENTS MARKHAM, K.C.B., President, in the Chair.

ELECTIONS.—*William Baird; Rowland Lloyd Drury; Captain Arthur Trevelyan Moore, R.E.; Baron Nettelbladt.*

The Paper read was:—
"Explorations in the Patagonian Cordilleras." By Dr. Hans Steffen.

Afternoon Technical Meeting, Tuesday, March 20, 1900.—Sir CLEMENTS MARKHAM, K.C.B., President, in the Chair.

The Paper read was:—
"Twelve Years' Work of the Ordnance Survey." By Colonel Sir John Farquharson, K.C.B., R.E.

GEOGRAPHICAL LITERATURE OF THE MONTH.

Additions to the Library.

By HUGH ROBERT MILL, D.Sc., LL.D., *Librarian*, R.G.S.

THE following abbreviations of nouns and the adjectives derived from them are employed to indicate the source of articles from other publications. Geographical names are in each case written in full:—

A. = Academy, Academie, Akademie.
Abh. = Abhandlungen.
Ann. = Annals, Annales, Annalen.
B. = Bulletin, Bollettino, Boletim.
Com. = Commerce.
C. Rd. = Comptes Rendus.
Erdk. = Erdkunde.
G. = Geography, Geographie, Geografia.
Ges. = Gesellschaft.
I. = Institute, Institution.
Iz. = Izvestiya.
J. = Journal.
k. u. k. = kaiserlich und königlich.
M. = Mitteilungen.
Mag. = Magazine.
Mem. = Memoirs, Mémoires.
Met. = Meteorological.
P. = Proceedings.
R. = Royal.
Rev. = Review, Revue.
S. = Society, Société, Selskab.
Sitzb. = Sitzungsbericht.
T. = Transactions.
V. = Verein.
Verh. = Verhandlungen.
W. = Wissenschaft, and compounds.
Z. = Zeitschrift.
Zap. = Zapiski.

On account of the ambiguity of the words *octavo*, *quarto*, etc., the size of books in the list below is denoted by the length and breadth of the cover in inches to the nearest half-inch. The size of the *Journal* is 10 × 6½.

A selection of the works in this list will be noticed elsewhere in the "Journal."

EUROPE.

Alpine Lakes. *Spelunca* **4** (1898): 168–170. **Viglino.**
Sur l'Excavation des Lacs alpins par les Glaciers. Par M. F. Viglino. *With Illustrations.*

Austria—Bohemia. *Globus* **77** (1900): 8–13. **Zemmrich.**
Die Zustände an der Sprachgrenze in Westböhmen. Von Dr. J. Zemmrich. *With Map.*

Austria—Geodesy.
Publicationen für die Internationale Erdmessung. Die Astronomisch-Geodätischen Arbeiten des K. und K. Militär-Geographischen Institutes in Wien. XIII. Band. Trigonometrische Arbeiten. 6. Die Netz-Ausgleichungen im westlichen Theile der Monarchie. Herausgegeben vom K. und K. Militär-Geographischen Institute (pp. viii. and 218); XIV. Band. Das Präcisions-Nivellement in der Oesterreichisch-Ungarischen Monarchie. IV. Süd-östlicher Theil (pp. viii. and 226); XV. Band. Trigonometrische Arbeiten. 7. Die Netz-Ausgleichungen im mittleren Theile der Monarchie (pp. x. and 210). XVI. Band. Astronomische Arbeiten. 5. Längenunterschied-Messungen Budapest-Wien, Krakau-Budapest und Budapest-Pola. Ausgleichung des Längennetzes. Anhang über Stromzeiten. Herausgegeben vom K. und K. Militär-Geographischen Institute. Wien, 1899. Size 12 × 9½, pp. vi. and 228. *Presented by the Institute.*

Belgium. **Cornet.**
Considérations sur l'évolution de la Sambre et de la Meuse (*Communication préliminaire*). Par J. Cornet. (Extrait des Annales de la Société géologique de Belgique, t. xxvii.) Liège, 1899–1900. Size 9½ × 6½, pp. [8]. *Presented by the Author.*

Belgium—Historical. *B.A.R. Belgique* **34** (1897): 745–753. **Piot.**
Les Commentaires de Jules César interprétés au point de vue de la Belgique. Par Ch. Piot.

Belgium—Historical. *B.A.R. Belgique* **36** (1898): 104–118. **Piot.**
Le camp de Labiénus pendant la guerre des Trévires. Par Ch. Piot.

Black Sea and Sea of Azov.
Résumé des observations hydrologiques faites dans la mer Noire et la mer d'Azof pendant les expeditions de 1890 et 1891. [In Russian.] St. Petersburg, 1899. Size 11 × 7½, pp. x. and 100. *Charts and Diagrams.*

Central Europe. *Deutsche Rundschau G.* **22** (1900): 202–211. **Herden.**
Die Wasserfälle der Sudeten. Von P. Herden. *With Illustrations.*

Denmark—Meteorology.
Annuaire météorologique pour l'année 1895. Deuxième partie. 1897. Première partie. Publié par l'Institut Météorologique de Danemark. Kjøbenhavn, 1898–1899. Size 14 × 9½, pp. (1895, 2 ptie.) 98; (1897, 1ère ptie.) 140. *Presented by the Danish Meteorological Institute.*

Europe—Anthropology. **Ripley.**
The Races of Europe, a Sociological Study (Lowell Institute Lectures). By William Z. Ripley, PH.D. Accompanied by a Supplementary Bibliography of the Anthropology and Ethnology of Europe, published by the Public Library of the City of Boston. London: Kegan Paul & Co., 1900. Size 9½ × 6½, pp. xxxii., 624, x., and 160. *Maps and Illustrations. Price* 18*s. net. Presented by the Publishers.*
This important work on the peoples of Europe is richly illustrated with type-photographs.

Europe—Climate. *Meteorolog. Z.* **16** (1899): 539–546. **Lesshaft.**
Die Einfluss der Wärmeschwankungen des Norwegischen Meeres auf die Luftcirkulation in Europa. Von Dr. Emil Lesshaft.
On the influence exercised by the temperature of the water in the Norwegian sea on the direction of the cyclone tracks across Europe, and thus upon the weather.

Europe—Food Supply. *J.R. Statistical S.* **62** (1899): 597–638. **Crawford.**
Notes on the Food Supply of the United Kingdom, Belgium, France, and Germany. By R. F. Crawford.

Europe—Historical. *B.A.R. Belgique* **36** (1898): 94–103. **Piot.**
Les Ecossais, dits Scoten ou Schotte, en Flandre. Par Ch. Piot.

France. *C. Rd.* **130** (1900): 146–148. **Bleicher.**
Sur la dénudation du plateau central de Haye ou Forêt de Haye (Meurthe-et-Moselle). Note de M. Bleicher.
The *Pays de Hayes* is a portion of the forest-covered belt of oolitic rocks which borders the Paris basin in the east. The land is very broken and cut into deep ravines, some of the characteristics of which form the subject of this paper.

France. *Mém. S. Spéléologie,* **No. 22** (1899): 1–52. **Décombaz.**
Explorations souterraines dans le Royans et le Vercors (2e Campagne). Par M. O. Décombaz. *With Plans and Illustrations.*

France. *Ann. G.* **9** (1900): 17–31. **Cora.**
Observations sur la route de Chamonix au Mont-Blanc. Par M. Guido Cora.

France—Caylar. *B.S. Languedoc. G.* **22** (1899): 1–8. **Rouville.**
Une application de géographie rationnelle: Le canton du Caylar (Hérault). Par P. G. de Rouville.

France—Languedoc. *B.S. Languedoc. G.* **22** (1899): 9–29. **Fondouce.**
Contribution à une faune historique du Bas Languedoc. Par Cazalis de Fondouce.

France—Military Geography. **Barré.**
La Géographie Militaire et les nouvelles méthodes géographiques. La France du Nord-Est. Par O. Barré. Paris: Berger-Levrault & Cie., 1899. Size 10 × 6½, pp. 124. *Maps and Illustrations.*

France—Roujan. *B.S. Languedoc. G.* **22** (1899): 30–35. **Rouville.**
Un résumé de l'histoire du globe: Le canton de Roujan (Hérault). Par P. G. de Rouville.

Germany. **Wahnschaffe.**
Erläuterungen zur Geologischen Spezialkarte von Preussen und den Thüringischen Staaten. Blatt Rüdersdorf, im Massstab 1: 25,000. Berlin, 1899. Size 10½ × 7½, pp. 76. *Map and Illustrations.*

Germany—Berlin. **Baschin.**
Die geographische Lage von Berlin. Die erdmagnetischen Elemente. Das Klima von Berlin. Von O. Baschin. (Sonderabdruck aus der Festgabe der Stadt Berlin für die Teilnehmer an dem VII. Internationaler Geographen-Kongress 1899.) Size 6½ × 4½, pp. 16. *Presented by the Author.*

Germany—Berlin. **Berendt.**

Geognostische Beschreibung der Umgegend von Berlin. Von G. Berendt. Zur Erläuterung einer zweiten Auflage der geologischen Uebersichtskarte der Umgegend von Berlin im Massstabe 1 : 100,000 in 2 Blättern. Herausgegeben von der Königlich Preussischen geologischen Landesanstalt. Berlin, 1899. Size 10½ × 7, pp. 60. *Presented by Dr. J. Scott Keltie.*

Germany—Prussia. **Keilhack.**

Thal- und Seebildung im Gebiet des Baltischen Höhenrückens. Von Dr. Keilhack. (VII. Internationaler Geographen-Kongress, Berlin, 1899.) Size 10 × 7, pp. 14. *Map. Presented by Dr. J. Scott Keltie.*

Germany—Saxony. ——

Kalender und Statistisches Jahrbuch für das Königreich Sachsen . . . auf das Jahr 1900. Dresden: C. Heinrich, 1899. Size 8 × 5½, pp. 244.

Greece—Corfu. *Oester. Monats. Orient* **25** (1899): 124–126. ——

Die Wirthschaftsverhältnisse von Corfu.

Holland. *Verh. K.A. Wetens. Amsterdam* **6**, 2 Sec. (1899): 1–38. **Lorié.**

Beschrijving van eenige nieuwe grondboringen. Door Dr. J. Lorié. *With Plate.*

Hungary—Transylvania. *B.S.G. Română* **20** (1899): 75–118. **Moldovan.**

Literatura geografică a Transilvaniei până la finea secolului al XVIII.-lea. Studiu de Silvestru Moldovan.

Italy. *Globus* **76** (1899): 345–348, 366–369. **Deecke.**

Die pleistocänen Landseen des Apennins. Von W. Deecke. *With Maps.*

Italy. **Baedeker.**

Italy. Handbook for Travellers. By Karl Baedeker. Third Part: Southern Italy and Sicily, with Excursions to the Lipari Islands, Malta, Sardinia, Tunis, and Corfu. Thirteenth Revised Edition. Leipsic: Karl Baedeker; London: Dulau & Co., 1900. Size 6½ × 4½, pp. lxviii. and 432. *Maps and Plans. Price* 6 *m. Presented by Messrs. Dulau & Co.*

Italy—Naples. **Neville-Rolfe.**

Trade of Naples and District for the year 1898 (Supplementary). Foreign Office, Annual No. 2330, 1899. Size 10 × 6, pp. 34. *Price* 2½*d.*

Italy—Sardinia. *Travel* **4** (1899): 347–353. **Wells.**

In Search of Brigands and Nuraghi. By Samuel Wells. *With Illustrations.*

Italy—Sicily. **Churchill.**

Trade of Sicily for the year 1898. Foreign Office, Annual No. 2331, 1899. Size 9½ × 6, pp. 42. *Price* 2½*d.*

Italy—Sicily. *Riv. G. Italiana* **6** (1899): 606–620. **Marinelli.**

Termini geografici dialettali raccolti in Sicilia. Per Olinto Marinelli.

Mediterranean. **Helmolt.**

Weltgeschichte. Herausgegeben von Hans F. Helmolt. Vierter Band. Die Randländer des Mittelmeers. Von Eduard Graf Wilczek, Dr. Hans F. Helmolt, Dr. Karl Georg Brandis, Prof. D. Wilhelm Walther, Dr. Heinrich Schurtz, Prof. Dr. Rudolf von Scala, Prof. Dr. Karl Pauli und Prof. Dr. Julius Jung. Leipzig und Wien: Bibliographisches Institut, 1900. Size 10½ × 7, pp. x. and 574. *Maps and Illustrations.*

The historical descriptions are based on geographical conditions, and there are many maps showing the division of countries at different periods.

Mediterranean—Corsica. *Scottish G. Mag.* **15** (1899): 639–646. ——

An Anthropogeographical Study of Corsica.

A summary of Prof. Ratzel's work.

Mediterranean—Cyprus. *J.R.I. British Architects* **7** (1899): 41–47. **Bilson.**

The Mediæval Architecture of Cyprus. Review of M. Enlart's *L'Art gothique et la Renaissance en Chypre.* By John Bilson. *With Illustrations.*

Mediterranean—Malta. **Strickland.**

Malta. Report for 1898. Colonial Reports, Annual No. 270, 1899. Size 9½ × 6, pp. 50. *Price* 3*d.*

Rumania. *B.S.G. Romând* **20** (1899): 41–64. **Van den Gheyn**

Les Populations Danubiennes, Roumains et Bulgares. Par le R. P. van den Gheyn.

Russia. *Petermanns M.* **45** (1899): 269–271. **Philippson**

Zur Morphologie des europäischen Russland. Von Prof. Dr. Alfred Philippson.

Russia—Odessa. **Mackie.**

Agriculture and Trade (Supplementary) of Odessa and District for the Year 1898. Foreign Office, Annual No. 2366, 1899. Size 10 × 6, pp. 42. *Price* 2½*d.*

Spain—Gibraltar. **Jackson.**

Gibraltar. Report for 1898. Colonial Reports, Annual No. 276, 1899. Size 10 × 6, pp. 28. *Price* 2*d.*

Sweden—Gothenburg. **Duff.**

Trade of Gothenburg and District for the year 1898. Foreign Office, Annual No. 2337, 1899. Size 10 × 6½, pp. 36. *Price* 2½*d.*

Turkey. *Globus* **76** (1899): 369–371. ———

Die Mauern von Konstantinopel. *With Illustrations.*

United Kingdom—Manchester Ship Canal. **Fletcher.**

Manchester Ship Canal. The Economic Results of the Ship Canal on Manchester and the surrounding district. By A. Woodroofe Fletcher, LL.B. Manchester: Chas. Sever, 1899. Size 8½ × 5½, pp. 44. *Presented by the Manchester Ship Canal Company.*

A statement of the progress of the Manchester ship canal in developing the district through which it passes.

ASIA.

Afghanistan. *Contemporary Rev.* (1900): 40–49. **Boulger**

Cabul and Herat. By Demetrius C. Boulger.

Central Asia. **Cobbold.**

Innermost Asia, Travel and Sport in the Pamirs. By Ralph P. Cobbold. London: W. Heinemann, 1900. Size 9 × 6, pp. xviii. and 354. *Maps, Portrait, and Illustrations. Price* 21*s. Presented by the Publisher.*

This volume contains the record of a journey through Kashmir to the Pamirs, Kashgar, South-Western Siberia, and back to India over the Pamirs again. There are also chapters on the political questions concerning the regions which were travelled through, and appendices dealing with the history, commerce, and mineral wealth of the regions, as well as the treaties regarding the "Anglo-Russian frontier" and a short bibliography of works in languages other than Russian.

China. *B.S.G. Paris* **20** (1899): 433–449. **François**

De Canton à Long-Tchéou. Par M. François. *With Maps.*

China. **Glass.**

Report by Mr. J. G. H. Glass on the Concessions of the Pekin Syndicate, Limited, in the Provinces of Shansi and Honan, China, with Estimates of Cost of Railways and other Works necessary for their development. 1899. Size 12½ × 8, pp. 174. *Map. Presented by the Pekin Syndicate, Limited.*

A comprehensive report on the resources of the territories for the commercial exploitation of which the Pekin Syndicate has obtained a concession from the Chinese Government.

China. **Kotvich and Borodovski.**

Liao-tung and its ports: Port Arthur and Ta-lien-wan. Historico-geographical description. By V. Kotvich and L. Borodovski. [In Russian.] St. Petersburg: A. Ilina, 1898. Size 9½ × 6½, pp. 48. *Map and Plans. Presented by M. L. Borodovski.*

China. *C. Rd.* **130** (1900): 184–185. **Leclère.**

Sur la Géologie de la Chine méridionale. Note de M. Leclère.

M. Leclère's geological surveys were made from Tongking in 1897–99, and effected a junction between the surveys in French Cochin-China and those of Richthofen and Loczy in Northern China. They include Yunnan, the southern edge of Sechuan, and finally the provinces of Kweicheou and Kwangsi.

China. *B.S.G. Com. Paris* **21** (1899): 294–304. **Monnier.**

La Chine d'aujourd'hui et la Chine de demain. Par M. Marcel Monnier.

China—Medical Reports.

China. Imperial Maritime Customs. II.—Special Series. No. 2. Medical Reports, for the half-year ended March 31, 1899. 57th Issue. Shanghai: London, P. S. King & Son, 1899. Size 11 × 8½, pp. 28. *Presented by the Inspector-General of Chinese Customs.*

China—Railways, etc. **Brandt.**

Von Brandt. Industrielle und Eisenbahn-Unternehmungen in China. (Abteilung Berlin-Charlottenburg der Deutschen Kolonial-Gesellschaft. Verhandlungen 1898–99. Heft 4.) Berlin: D. Reimer (Ernst Vohsen), 1899. Size 9 × 6, pp. [20]. *Map.*

Contains a map of the projected railway system in China, indicating the share in the enterprise claimed by each of the foreign powers.

China Sea—Directory.

Supplement 1898 relating to China Sea Directory, vol. iii. Third Edition, 1894. Corrected to July 13, 1898. London: J. D. Potter, 1898. Size 10 × 6½, pp. 32. *Price* 4*d*. *Presented by the Hydrographer, Admiralty.*

India.

American Trade with India. A Report by the Philadelphia Commercial Museum. Philadelphia, 1898. Size 9½ × 6, pp. 44.

India—Andaman and Nicobar Islands. *J.S. Arts* **48** (1899): 105–125. **Temple.**

Round about the Andamans and Nicobars. By Colonel R. C. Temple. *With Map.*

India—Bengal.

List of Consultations, Proceedings, etc.: Bengal, 1704–1858. Preserved in the Record Department of the India Office, London. London: Eyre & Spottiswoode, 1899. Size 13½ × 8½, pp. iv. and 516. *Presented by the India Office.*

An index of official documents in the Bengal archives.

India—Ceylon. **Leclercq.**

Une ville morte à Ceylan. Par Jules Leclercq. (Extrait des *Bulletins de l'Académie royale de Belgique* (Classe des lettres, etc.), No. 6 (juin), 1899.) Bruxelles, 1899. Size 9 × 6, pp. 485–524. *Presented by the Author.*

India—Ceylon. **Thorburn.**

Ceylon. Annual Report for 1898. Colonial Reports, Annual No. 274, 1899. Size 9½ × 6, pp. 32. *Price* 2*d*.

India—Lepcha Dictionary. **Mainwaring and Grünwedel.**

Dictionary of the Lepcha Language. Compiled by the late General G. B. Mainwaring, revised and completed by Albert Grünwedel. Berlin: printed by Unger Brothers, 1898. Size 10½ × 7½, pp. xvi. and 552. *Presented by the Bengal Government.*

India—Vizagapatam. **Bion.**

Notes on the Meteorology of Vizagapatam, part ii. By. W. A. Bion. Calcutta, 1899. Size 9 × 6½, pp. 41–152. *Diagrams. Presented by the Meteorological Office, Government of India.*

Japan—Formosa. **Griffiths.**

Trade of Tainan for the year 1898. Foreign Office, Annual No. 2341, 1899. Size 10 × 6½, pp. 16. *Price* 1*d*.

Japan—Formosa. **Layard.**

Trade of North Formosa for the year 1898. Foreign Office, Annual No. 2339, 1899. Size 9½ × 6, pp. 18. *Price* 1½*d*.

Malay Archipelago—Sumatra. **Parker.**

Imp. and Asiatic Quarterly Rev. **9** (1900): 127–144.

The Island of Sumatra. By E. H. Parker.

On the history of Sumatra and the identification of old place-names.

Malay Peninsula. **Swettenham.**

The Real Malay, Pen Pictures. By Sir Frank Athelstane Swettenham, K.C.M.G. London and New York: John Lane, 1900. Size 8 × 5½, pp. x. and 296. *Price* 6*s*.

Malay Peninsula—Folklore. **Skeat.**

Malay Magic, being an Introduction to the Folklore and Popular Religion of the Malay Peninsula. By Walter William Skeat. With a Preface by Charles Otto

Blagden. London: Macmillan & Co., 1900. Size 9½ × 6, pp. xiv. and 686. *Illustrations. Price* 21*s. net. Presented by the Publishers.*

A comprehensive study of the folklore of the Malays, founded upon the personal observations of the author mainly in the state of Selangor, and extended by citations from the works of other writers. The preface points out the practical importance of the psychology of subject-races, and shows that political errors might be avoided if the motives swaying the native mind were understood. The book is illustrated by pictures of some of the magical "properties" in use by the Malays.

Persia—Khorassan. **Whyte.**

Trade of Khorassan for the year 1898-99. Foreign Office, Annual No. 2368, 1899. Size 9½ × 6, pp. 16. *Price* 1*d.*

Russia—Caucasus. *Ann. G.* **9** (1900): 32-42. **Flahault.**

La végétation du Caucase, d'après M. Gustav Radde. Par M. Ch. Flahault. *With Map.*

Russia—Siberia. *Petermanns M.* **45** (1899): 29-37, 228-235, 261-267. **Krahmer.**

Der Anadyr-Bezirk nach A. W. Olssufjew. Von Generalmajor z. D. Krahmer.

Russia—Siberia. *Scottish G. Mag.* **16** (1900): 17-29. **Simpson.**

The New Siberia. By J. Y. Simpson, M.A.

Russia—Transcaucasia. **Stevens.**

Agriculture in Transcaucasia for the year 1899. Foreign Office, Annual No. 2365, 1899. Size 9½ × 6, pp. 10. *Price* 1*d.*

Russian Empire. **Bookwalter.**

Siberia and Central Asia. By John W. Bookwalter. Illustrated from photographs taken by the author. Second Edition, with a Map. London: C. A. Pearson, Ltd., 1900. Size 9½ × 6½, pp. xxxii. and 548. *Price* 21*s. Presented by the Publishers.*

The author, an American business man, describes in a simple, straightforward way his observations on a journey along the Siberian railway, and a subsequent visit to Central Asia. The descriptions are rendered effective by a large number of snap-shot photographs, which give an excellent idea of the nature of the country.

Siam.

American Trade with Siam. A Report by the Philadelphia Commercial Museum. Philadelphia, 1898. Size 9 × 6, pp. 32.

Siam—Chiengmai. **Black.**

Trade of Chiengmai and District for the year 1898. Foreign Office, Annual No. 2362, 1899. Size 9½ × 6, pp. 16. *Price* 1*d.*

Turkey—Asia Minor. *Atti R.A. Lincei, Rendiconti* **8** (1899): 365-368. **Agamennone.**

Il terremoto di Balikesri (Asia M.) del 14 settembre 1896. Nota di G. Agamennone.

AFRICA.

Abyssinia. *B.S.G. Italiana* **1** (1900): 104-120. **Rossini.**

Ricerche e studi sull' Etiopia. Relazione del socio C. Conti Rossini. *With Maps.*

Algeria—Bougie. **Ludwig Salvator.**

Bougie, die Perle Nord-Afrikas. Prag: H. Mercy Sohn, 1899. Size 18 × 13½, pp. viii. and 122. *Plan and Illustrations. Presented by H. I. and R. H. the Archduke Ludwig Salvator.*

This is a description with handsome illustrations of a small island, which has been treated to a more superb volume than even the Archduke himself has hitherto produced in his artistic treatises on the islands of the Mediterranean.

Azores. *Ann Hydrographie* **28** (1900): 1-2. **Schröder.**

Azoren. Aus dem Reisebericht S.M.S. *Moltke*, Kommandant Kapt. z. S. Schröder. August 1899. *With Plan and View.*

Cape Colony—East London. **Israel and Reinicke.**

Ann Hydrographie **27** (1899): 592-599.

East London. Nach Berichten vom Kaiserlichen Konsulat daselbst und von den Kapt. F. H. Israel und G. Reinicke. *With Plan.*

Congo State. *B.S.G. Com. Paris* **21** (1899): 305-314. **Dyé.**

Les voies de transport dans le Haut Oubangui. Par M. A. H. Dyé. *With Map.*

Congo State. **Lycops.**

Codes Congolais et lois usuelles en vigueur au Congo, collationnés d'après les textes officiels et annotés par Alphonse Lycops. Bruxelles: V. F. Larcier, 1900. Size 7 × 4½, pp. 604. *Presented by the Author.*

An epitome of the very numerous laws, regulations, and disabilities which have effect in the Congo State, prefaced by a political history of the state.

East Africa—Historical. **Strandes.**

Die Portugiesenzeit von Deutsch- und Englisch-Ostafrika. Von Justus Strandes. Berlin: Dietrich Reimer (Ernst Vohsen), 1899. Size 10 × 7, pp. xii. and 348. *Maps and Illustrations. Presented by the Publisher.*

On the period of Portuguese predominance in East Africa, with special reference to Kilwa and Mombasa.

Eastern Africa. *B.S.G. Italiana* **1** (1900): 121–142. **Bulatovich.**

Dall' Abissinia al lago Rodolfo per il Caffa. Conferenza del capitano A. K. Bulatovich. Con note di G. Roncagli. *With Maps.*

Egypt. ——

Dictionnaire géographique de l'Égypte. Le Caire, 1899. Size 11 × 7½, pp. xxii. and 650.

This dictionary contains the name of every inhabited place in Egypt, arranged alphabetically according to the transliteration of the name in the Roman alphabet, but accompanied in each case by the name in the original Arabic character. Brief particulars of position, population, etc., are also supplied.

Egypt. *B.S. Khédiv. G.* **5** (1899): 189–202. **Fourtan.**

Les environs des Pyramides de Ghizeh. Par M. R. Fourtan.

Egypt. **Cameron.**

Trade of Port Said and Suez for the year 1898. Foreign Office, Annual No. 2338, 1899. Size 10 × 6, pp. 12. *Price* 1*d.*

Egypt—Folk-lore. *Abh. Deutsch. Morgenländ. Ges.* **11** (1899): 1–243. **Hartmann.**

Lieder der Libyschen Wüste. Die Quellen und die Texte nebst einem Exkurse über die bedeutenderen Beduinenstämme des westlichen Unterägypten. Von Martin Hartmann.

Egypt—People. *B.S. Khédiv. G.* **5** (1899): 203–248. **Piot.**

Causerie ethnographique sur le Fellah. Par Piot Bey.

Egypt—Sand-Dunes. **Cornish.**

On Desert Sand-Dunes bordering the Nile Delta. By Vaughan Cornish. (From the *Geographical Journal* for January, 1900.) Size 10 × 6½, pp. 32. *Maps and Illustrations.*

Egypt—Upper Nile. *B.S.G. Marseille* **22** (1898): 401–410. **Teisseire.**

La question du Haut-Nil au point de vue juridique, communication de M. Raymond Teisseire.

French Congo. *B.S.G. Paris* **20** (1899): 412–413. **Guy.**

Note sur les explorations de M. Perdrizet. Par Camille Guy. *With Map.*

French Guinea. *B.S.G. Paris* **20** (1899): 365–411. **Salesses.**

De Conakry au Niger. Par le Capitaine E. Salesses. *With Map.*

French Guinea. **Arthur.**

Trade of French Guinea for the year 1898. Foreign Office, Annual No. 2364, 1899. Size 10 × 6, pp. 20. *Price* 1½*d.*

German East Africa. *M. Deutsch. Schutzgeb.* **12** (1899): 228–235. **Glauning.**

Bericht des oberleutnants Glauning über die Fortschritte der Pendelexpedition.

German East Africa—Lake Kivu. *M. Deutsch. Schutzgeb.* **12** (1899): 235–237. **Kandt.**

Bericht von Dr. R. Kandt über seine Reisen am Kivusee. *With Map.*

German South-West Africa. *M. Deutsch. Schutzgeb.* **12** (1899): 225–227. ——

Regenmessungen in Deutsch-Südwestafrika.

German West Africa—Kamerun. *M. Deutsch. Schutzgeb.* **12** (1899): 222–224. ——

Begleitworte zur Karte der Pflanzungsgebiete am Kamerungebirge. *With Map.*

German West Africa—Kamerun. *M. Deutsch. Schutzgeb.* **12** (1899): 201–218. **Conrau.**
Im Lande der Bangwa. Von G. Conrau.
Bei den nordöstlichen Bangwa und im Lande der Kabo und Basosi. Von G. Conrau. *With Map.*

German West Africa—Kamerun. *M. Deutsch. Schutzgeb.* **12** (1899): 221–222. **Moisel.**
Begleitworte zu der Karte der Wegeaufnahmen G. Conraus im Lande der Banyang, Bangwa, Kabo, Basosi und Bafo. Von Max Moisel.

German West Africa—Kamerun. *M. Deutsch. Schutzgeb.* **12** (1899): 218–219. **Plehn.**
Meteorologische Beobachtungen am Gouvernementsgebäude in Kamerun. Von Dr. A. Plehn.

German West Africa—Togo. *M. Deutsch. Schutzgeb.* **12** (1899): 194–195. **Diehl.**
Meteorologische Beobachtungen an der Missionsstation Ho. Von Missionar H. Diehl.

German West Africa—Togo. *M. Deutsch. Schutzgeb.* **12** (1899): 175–194. **Hupfeld.**
Die Eisenindustrie in Togo. Von Fr. Hupfeld. *With Illustrations.*

Lake Chad. *Mouvement G.* **16** (1899): 541–545. ——
Autour du Tchad.

Madagascar. **Granddidier.**
Sur l'origine des Malgaches. Par Alfred Grandidier. (Extrait de la 'Revue de Madagascar.') Paris: P. Dupont, 1899. Size 9½ × 6, pp. 12. *Illustrations.*

Madagascar. **Turner.**
Trade of Madagascar for the year 1898. Foreign Office, Annual No. 2334, 1899. Size 10 × 6, pp. 12. *Price* 1*d.*

Madeira. **Spence.**
Trade of Madeira for the year 1898. Foreign Office, Annual No. 2333, 1899. Size 10 × 6, pp. 10. *Price* 1*d.*

Marocco. *Questions Dipl. et Colon.* **8** (1899): 321–331. **Kryszanowski.**
Le Maroc français. Par L. Kryszanowski.

Nigeria. **Goldie.**
Report by Sir George Goldie on the Niger Sudan Campaign (1897), with Miscellaneous Documents, including the Military Report by Major Arnold, Commandant of Royal Niger Constabulary. London: Witherby & Co. Size 13 × 8½, pp. 24. *Maps.*

Portuguese East Africa. **Costa.**
Cap. Gomes da Costa. Gaza, 1897–98. Lisboa, M. Gomes [1899]. Size 10 × 6½, pp. 176. *Maps and Illustrations. Presented by the Author.*

Portuguese East Africa. **Worsfold.**
Portuguese Nyassaland. An account of the Discovery, Native Population, Agricultural and Mineral resources, and Present Administration of the territory of the Nyassa Company, with a Review of the Portuguese Rule on the East Coast of Africa. By W. Basil Worsfold. London: Low & Co., 1899. Size 9 × 5½, pp. vi. and 296. *Maps (in cover) and Illustrations. Price* 7*s.* 6*d. net.*
A collection of facts derived from official and other sources bearing on the character and resources of a comparatively little known region of Portuguese East Africa.

Portuguese West Africa. **Casement.**
Trade of Angola for the years 1897 and 1898. Foreign Office, Annual No. 2363, 1899. Size 9½ × 6, pp. 38. *Price* 2½*d.*

Réunion. **Bennett.**
Trade of Réunion for the year 1898. Foreign Office, Annual No. 2350, 1899. Size 10 × 6, pp. 10. *Price* 1*d.*

Somaliland—Bottegò's Second Expedition. *Science* **10** (1899): 951–955. **Sclater.**
Results of the Second Bottegò Expedition into Eastern Africa. By Dr. P. L. Sclater.

St. Helena. *Imp. and Asiatic Quarterly Rev.* **9** (1900): 98–107. **Sterndale.**
St. Helena in the Present Time. By His Excellency R. A. Sterndale, Governor of St. Helena.

Sierra Leone. **Nathan.**
Sierra Leone. Report for 1898. Colonial Reports, Annual No. 273, 1899. Size 9½ × 6, pp. 38. *Price* 2*d.*

South Africa. **Brown.**

The Guide to South Africa for the use of Tourists, Sportsmen, Invalids, and Settlers. With coloured maps, plans, and diagrams. Edited annually by A. Samler Brown and G. Gordon Brown, for the Castle Mail Packets Company, Limited. 1899–1900 Edition. Seventh Edition. London: Low & Co., 1899. Size 7½ × 5, pp. xlviii. and 420. *Price* 2*s.* 6*d.*

The present edition of this concise and handy Guide has been revised up to July of last year. In addition to the usual Guide-book information, it contains a great deal of condensed and statistical matter bearing on South Africa generally, and is well supplied with maps.

South Africa. **Theal.**

South Africa (the Cape Colony, Natal, Orange Free State, South African Republic, Rhodesia, and all other territories south of the Zambesi.). By George M'Call Theal, LL.D. Seventh Impression. (Fifth Edition.) (The Story of the Nations.) London: T. Fisher Unwin, 1900. Size 8 × 5¼, pp. xxviii. and 452. *Maps and Illustrations. Price* 5*s.*

A summary of events in South African history from the discovery of the Cape by the Portuguese in 1486 onwards. The supplementary chapter deals with the latest phase of South African history—the outbreak of the present war.

South Africa—Bibliography. *B. New York Public Library* **3** (1899): 429–461. ———

Works relating to South Africa.

South Africa—Climate. **Scholtz.**

The South African Climate, including Climatology and Balneology, and discussing the advantages, peculiarities, and capabilities of the country as a health resort—more particularly with reference to affections of the chest. By William C. Scholtz, M.D. London: Cassell & Co., 1897. Size 9 × 6, pp. 200. *Illustrations.*

Zanzibar. **Cave.**

Trade of Zanzibar for the year 1898. Foreign Office, Annual No. 2351, 1899. Size 9½ × 6, pp. 20. *Price* 1½*d.*

NORTH AMERICA.

Alaska. **Moser, etc.**

Treasury Department, United States Coast and Geodetic Survey. Bulletins, Nos. 37–40. Alaska: Washington, 1899. Size 12 × 9½, pp. 113–204. *Charts. Presented by the U.S. Treasury Department.*

Alaska. *National G. Mag.* **11** (1900): 29–31. **Preston.**

The Copper River Delta. By E. D. Preston.

Alaska—Cape Nome District. *National G. Mag.* **11** (1900): 15–23. **Schrader.**

The Cape Nome Gold District. By F. C. Schrader. *With Map and Illustrations.*

On the remarkable gold-diggings on the extreme west of Alaska discovered in 1899 between tide-marks on the seashore.

America—Name. *Naturw. Wochenschrift* **14** (1899): 592–594. ———

Woher hat "Amerika" seinen Namen?

Brazil—Coffee. ———

Coffee Production in Brazil and Consumption in the United States. Foreign Office, Miscellaneous, No. 512, 1899. Size 10 × 6½, pp. 8. *Price* ½*d.*

Brazil—Rio Grande do Sul. **Staniforth.**

Trade of Rio Grande do Sul and District for the year 1898. Foreign Office, Annual No. 2332, 1899. Size 9½ × 6, pp. 26. *Chart. Price* 4*d.*

Chile—Atacama Desert. *Z. Ges. Erdk. Berlin* **34** (1899): 281–311. **Darapsky.**

Zur Geographie der Puna de Atacama. Von L. Darapsky. *With Maps.*

Canada. **Barlow.**

Report on the Geology and Natural Resources of the area included by the Nipissing and Temiscaming Map-Sheets, comprising portions of the District of Nipissing, Ontario, and of the County of Pontiac, Quebec. By Alfred Ernest Barlow, M.A.—Geological Survey of Canada, part i., Annual Report, vol. x. Ottawa, 1899. Size 10 × 6½, pp. 302. *Maps (separate) and Illustrations. Presented by the Geological Survey of Canada.*

Canada. *B.S.G. Paris* **20** (1899): 450–461. **Legal.**

Au Nord-ouest canadien. Les Pieds-Noirs. Par Mgr. Legal.

Canada—British Columbia. *Nautical Mag.* 69 (1900): 16–19. **Small.**
Inland Waterways of British Columbia. By H. B. Small.

Canada—Hudson's Bay Company. **Willson.**
The Great Company (1667–1871), being a History of the Honourable Company of Merchants-Adventurers trading into Hudson's Bay. Compiled from the Company's Archives, from Diplomatic Documents and State Papers of France and England, from the Narratives of Factors and Traders, and from many Accounts and Memoirs, by Beckles Willson. With an Introduction by Lord Strathcona and Mount Royal, Governor of the Hudson's Bay Company. 2 vols. London: Smith, Elder & Co., 1900. Size 8½ × 5½, pp. (vol. i.) xxx. and 340; (vol. ii.) x. and 370. *Maps and Portraits. Price* 18*s. Presented by the Publishers.*

A fascinating narrative of the career of the Hudson Bay Company in the north-west of Canada from the time of its foundation by Prince Rupert in 1670 to the relinquishment of territorial rights in 1870. A map is given, showing the posts of the Company at the period of its greatest extension before the settlement of the Oregon dispute, and the history is rendered interesting throughout by biographical notices and anecdotes of the leading organizers and pioneers.

Canada—Ontario. **McInnes.**
Report on the Geology of the Area covered by the Seine River and Lake Shebandowan Map-Sheets, comprising Portions of Rainy River and Thunder Bay Districts, Ontario. By William McInnes, B.A. (Geological Survey of Canada. Part H, Annual Report, vol. x.) Ottawa, 1899. Size 10 × 6½, pp. 66. *Maps (separate). Presented by the Geological Survey of Canada.*

Chile—Copper. *An. S. Ci. Argentina* 48 (1899): 209–238. **Jiménez.**
La industria del cobre en Chile de Juan Velásquez Jiménez.

Costa Rica. *Globus* 76 (1899): 348–353. **Sapper.**
Ein Besuch bei den Guatusos in Costarica. Von Dr. Carl Sapper. *With Illustrations.*

French Guiana. *Tour du Monde* 5 (1899): 589–600. **Brousseau.**
La territoire contesté Franco-Brésilien. Par M. Georges Brousseau. *With Map and Illustrations.*

French and Dutch Guiana. **Pigott and Wacongne.**
Trade of French and Dutch Guiana for the year 1898. Foreign Office, Annual No. 2360, 1899. Size 9½ × 6, pp. 14. *Price* 1*d.*

Jamaica. *Scottish G. Mag.* 15 (1899): 628–639. **Hill.**
A Sketch of the Geology of Jamaica. After R. T. Hill of the U.S. Geological Survey.

Jamaica. *Scottish G. Mag.* 15 (1899): 617–627. **Nash.**
Jamaica, with remarks on some of the other West Indian Islands. By Alfred G. Nash. *With Map and Illustrations.*

Mexico. *B.S.G. de l'Est* (1899): 98–110. **Diguet.**
Relation sommaire d'un voyage au versant occidental du Mexique. Par M. Léon Diguet.

An extract from the *Bulletin du Muséum d'histoire naturelle*, 1898, No. 8, p. 345.

Mexico. **Lemcke.**
Mexico, das Land und seine Leute. Ein Führer und geographisches Handbuch unter besonderer Berücksichtigung der gegenwärtigen wirtschaftlichen Verhältnisse des Landes. Von Heinrich Lemcke. Berlin: A. Schall, 1900. Size 12½ × 10, pp. viii. and 290. *Map and Illustrations. Price* 10*s.*

A geographical description of Mexico, with special reference to the economic conditions of the country and the prospects of future development.

Nicaragua. **Chambers.**
Trade of Nicaragua for the year 1898. Foreign Office, Annual No. 2329, 1899. Size 9½ × 6, pp. 16. *Price* 1*d.*

St. Vincent. **Thompson.**
St. Vincent. Report for 1898. Colonial Reports, Annual No. 281, 1899. Size 9½ × 6, pp. 20. *Price* 1½*d.*

Trinidad. **Knollys.**
Trinidad. Report for 1898. Colonial Reports, Annual No. 272, 1899. Size 9½ × 6, pp. 52. *Price* 3*d.*

West Indies. **Jay.**

A Glimpse of the Tropics; or, Four Months Cruising in the West Indies. By E. A. Hastings Jay, LL.B. London: Low & Co., 1900. Size 8 × 5½, pp. 284. *Map and Illustrations. Price* 6*s. Presented by the Author.*

A diary of a trip in a Royal Mail steamer, with some historical notes as to the islands visited. The term "roaring forties" applied to north latitudes appears to be new.

West Indies—Jamaica. **Hill.**

The Geology and Physical Geography of Jamaica: Study of a type of Antillean Development. Based upon Surveys made for Alexander Agassiz. By Robert T. Hill. With an Appendix on some Cretaceous and Eocene Corals from Jamaica. By T. Wayland Vaughan. (Bulletin of the Museum of Comparative Zoology at Harvard College, vol. xxxiv.) Cambridge, Mass., 1899. Size 9½ × 6, pp. 256. *Maps and Plates. Presented by the Author.*

CENTRAL AND SOUTH AMERICA.

Argentina—Patagonia. *B.S.R. Belge G.* **23** (1899): 366–374. **Lecointe.**

Voyage d'hiver en Patagonie. Par M. G. Lecointe. *With Map.*

A journey up the valley of the Rio Santa Cruz to Lake Viedma and back to the mouth of the river, carried out during the detention of the *Belgica* in the Strait of Magellan from June to August.

Argentine Republic. ———

Anuario de la Dirección General de Estadística correspondiente al Año 1898. Tomo ii. Buenos Aires, 1899. Size 11 × 7½, pp. 428.

Argentine Republic. *Ann. Hydrographie* **28** (1900): 11–14. **Danielssen and Hansen.**

Zur Küstenkunde von Argentinien. Nach Berichten des Kapt. B. H. Danielssen und des Kapt. H. Hansen.

Argentine Republic. *B.S.G. Com. Paris* **21** (1899): 364–393. **Machon.**

Voyage dans l'Argentine Sud. Par M. le Dr. Machon.

Argentine Republic—Buenos Aires. *P.I. Civil Engineers* **138** (1899): 170–243. **Dobson.**

Buenos Ayres Harbour Works. By J. M. Dobson. *With Plans and Sections.*

Argentine Republic—Ports. **Figueroa.**

Estudios sobre puertos en la Provincia de Buenos Aires. Segunda Parte. Costa marítima fluvial del Rio de La Plata. Por el Ing. Julio B. Figueroa. Text and Atlas. La Plata, 1898. Size (Text) 11 × 7½, (Atlas) 14½ × 11, pp. 308. *Presented by the Argentine Government.*

On the ports of the Argentine Republic, with a discussion of the tides, depths, and trade.

Bolivia. *J.S. Arts* **48** (1900): 234–243. **Conway.**

Some of the Undeveloped Resources of Bolivia. By Sir Martin Conway. *With Map.*

An account of the mineral wealth and the vegetable products of Bolivia, with special reference to the Indiarubber forests. Particulars are given as to the supply of labour and the means of communication.

Central America. *Verh. Ges. Erdk. Berlin* **26** (1899): 464–466. **Sapper.**

Herr Dr. Carl Sapper. Ueber seine Reisen in Central-Amerika.

A note on this paper appears in the *Journal* for March.

Costa Rica. *Globus* **77** (1900): 1–8. **Sapper.**

Ein Besuch bei den Chirripó- und Talamanca- Indianern von Costarica. Von K. Sapper. *With Illustrations.*

Nicaragua. *B.S.R.G. d'Anvers* **23** (1899): 309–366. **Jalhay.**

La République de Nicaragua, Notice historique, géographique et statistique. Par M. Henry Jalhay.

Porto Rico. **Hill.**

Notes on the Forest Conditions of Porto Rico. By Robert T. Hill. (U.S. Department of Agriculture, Division of Forestry. Bulletin No. 25.) Washington, 1899. Size 9½ × 6, pp. 48. *Map and Plates.*

A note on this paper appears in the *Journal* for March.

AUSTRALASIA AND PACIFIC ISLANDS.

Australia—River Murray. **Murray.**

Twelve Hundred Miles on the River Murray. By A. S. Murray. With Facsimile Illustrations in Colours by the Author. Australia: G. Robertson & Co.; London, J. S. Virtue & Co. 1898. Size 13 × 18, pp. 36. *Presented by the Publishers.*

Illustrated by facsimiles of the author's remarkably effective water-colours, representing the typical scenery of this most typical Australian river.

British New Guinea. **Le Hunte.**

Despatch from His Excellency the Lieutenant-Governor of British New Guinea reporting Visit of Inspection to certain places on the North-east Coast of the Possession. [No. 31] (pp. 10). Despatch reporting visit to head of Milne Bay to arrest certain Natives who had been guilty of an attack on Europeans. [No. 32] (pp. 4). Despatch reporting conclusion of Visit of Inspection round the Coast and islands of the Possession. [No. 34] (pp. 4). Despatch reporting proceedings from 14th June to date of arrival in Brisbane. [No. 56] (pp. 4). Brisbane, 1899. Size 13½ × 8½. *Presented by the Colonial Office.*

Easter Island. **Barclay, Powell, Clark.**

P.R.G.S. Australasia: S. Australian Br. 3 (1899): 127–146.

Easter Island and its Colossal Statues, by Captain H. V. Barclay, R.N., including Detailed Report upon Easter Island, or Rapa-nui, by Commodore W. Ashmore Powell, R.N., and calling at Sala-y-Gomez and Easter Islands, by Commander Bouverie F. Clark, R.N. *With Map and Illustrations.*

New South Wales. **Coghlan.**

The Wealth and Progress of New South Wales, 1897–8. By T. A. Coghlan. Eleventh Issue. Sydney, 1899. Size 9 × 6, pp. 1084. *Diagram Map. Presented by the Agent-General for New South Wales.*

New South Wales. *J.R. Colonial I.* 31 (1900): 93–120. **Stephen.**

Reminiscences of New South Wales. By the Hon. Septimus A. Stephen.

Pacific Islands. *Naturw. Wochenschrift* 15 (1900): 49–55, 61–67. **Frobenius.**

Die Schilder der Oceanier. Von L. Frobenius. *With Illustrations.*

On the varieties of shields in use amongst the tribes inhabiting the Pacific islands.

Pacific Islands. *Verh. Ges. Erdk. Berlin* 27 (1900): 74–78. **Strauch.**

Zur Nomenklatur der Südsee-Inseln. Von F. Stranch.

Pacific Ocean. *American J. Sci.* 9 (1900): 33–43. **Agassiz.**

Explorations of the "Albatross" in the Pacific Ocean. By Alexander Agassiz.

Pacific Ocean. *Science* 11 (1900): 92–98. **Agassiz.**

Cruise of the *Albatross.* II. By Dr. A. Agassiz.

POLAR REGIONS.

Antarctic—Belgian Expedition. *La G., B.S.G. Paris* (1900): 81–92. **Racovitza.**

Résultats généraux de l'expédition antarctique belge. Par M. E. Racovitza. *With Map.*

Antarctic—German Expedition. **Drygalski.**

Verh. Ges. Erdk. Berlin 26 (1899): 452–463.

Plan und Aufgaben der Deutschen Südpolar-Expedition. Von Prof. Dr. Erich von Drygalski.

Arctic—Bering Sea. *Tour du Monde* 5 (1899): 601–612. **Zenzinoff.**

La Chasse aux ours marins de la Mer de Béring. Résumé du rapport inédit d'une mission officielle russe. Par B. de Zenzinoff. *With Map and Illustrations.*

Arctic Currents. *B.G.S. Philadelphia* 2 (1899): 71–75. **Bryant.**

Drift Casks to determine Arctic Currents. By Henry G. Bryant.

A number of small casks, built of great strength and provided with a written request to the finder to communicate with the Philadelphia Geographical Society, were sent out last summer to be placed by whalers on the solid floe ice in the arctic sea reached through Bering strait, in the hope that they would eventually drift out and be recovered on the Atlantic side.

German Antarctic Expedition. *Nature* **61** (1900): 318–321. **Drygalski.**

The German Antarctic Expedition. By Prof. Erich von Drygalski.

Spitsbergen. **Garwood.**

Additional Notes on the Glacial Phenomena of Spitsbergen. By E. J. Garwood. [From the *Quarterly Journal of the Geological Society* for November, 1899, vol. lv.] Size 9 × 6, pp. [12]. *Map and Illustrations. Presented by the Author.*

MATHEMATICAL GEOGRAPHY.

Cartography. *Science* **11** (1900): 181–186. **Lindenkohl.**

Leitfaden der Kartenentwurfslehre für Studierende der Erdkunde und deren Lehrer, bearbeitet von Prof. Dr. Karl Zöppritz. Zweiter Auflage, herausgegeben von Dr. Alois Blundau. Erster Theil. [Review.] By Dr. A. Lindenkohl.

This is a more than usually thorough review, forming to some extent a brief English abstract of the work noticed.

Geodesy. ———

The Earth Measured. By a Member of the Chicago Astronomical Society. Second edition. Chicago, for private circulation, 1899. Size 9½ × 6½, pp. 40.

Geographical Instrument. *Vidensk. Skrifter* (1899) (No. 2): 1–70. **Mohn.**

Das Hypsometer als Luftdruckmesser und seine Anwendung zur Bestimmung der Schwerekorrektion. Von H. Mohn.

Geographical Tables. *Nautical Mag.* **69** (1900): 1–14. **Goodwin.**

Spherical Traverse Tables and their Uses. By H. B. Goodwin, M.A.

Geophysics. *B.A.R. Belgique* **34** (1897): 1013–1019. **Folie.**

Sur des termes de nutation insensibles pour la Terre entière, sensibles pour l'écorce terrestre. Par F. Folie.

Geophysics. *Mém. A.R. Belgique* **53, 6** (1898): 1–39. **Folie.**

Théorie du mouvement de rotation de l'écorce solide du globe. Fondements de l'astronomie sphérique du xx^e^ siècle. Par F. Folie.

On the mathematical theory of the movement of the crust of the Earth as a whole with respect to the fluid interior, as a basis of spherical astronomy.

Geophysics. *Sitzb. A.W. Wien* **107,** Abth. II. a. (1898): 1059–1112. **Oekinghaus.**

Ueber die zunahme der Dichtigkeit, Abplattung und Schwere im Innern der Erde auf Grundlage einer neuen Hypothese. Von E. Oekinghaus.

On the increase in density, polar flattening, and force of gravity towards the centre of the Earth according to a new hypothesis.

Latitude Changes. *B.A.R. Belgique* **34** (1897): 238–247. **Folie.**

Note préliminaire sur les trois périodes de la variation des latitudes. Par F. Folie.

PHYSICAL AND BIOLOGICAL GEOGRAPHY.

Limnology. *Science* **11** (1900): 253–255. **Birge.**

Some of the Problems of Limnology. By Prof. E. A. Birge.

Prof. Birge treats limnology as if the word meant the study of the living organisms of lakes. This meaning, we believe, was never contemplated by the originator of the term. Limnobiology is a term more descriptive of the paper before us.

Meteorology. *Nineteenth Century* **47** (1900): 94–102. **Bacon.**

Climate and the Atmosphere. By the Rev. John M. Bacon.

Meteorology—Evaporation. **Mazelle.**

Sitzb. A.W. Wien **107** Abth. II. a. (1898): 280–303.

Verdunstung des Meerwassers und des Süsswassers. Von Eduard Mazelle.

On the evaporation of sea-water and fresh water.

Meteorology—Rainfall. *G.Z.* **6** (1900): 89–96. **Brückner.**

Ueber die Herkunft des Regens. Von Eduard Brückner.

Meteorology—Temperature. *Meteorolog. Z.* **16** (1899): 529–539. **Trabert.**

Die Bekämpfung der Frostgefahr. Von Dr. Wilh. Trabert.

On the methods of avoiding the bad effects of frost on crops by making artificial clouds of smoke to check radiation, and by other expedients. Reference is made to

Mr. Hammon's work, 'Frost: when to expect it and how to lessen the injury therefrom,' published by the United States Weather Bureau.

Oceanography.

Die Deutsche Tiefsee-Expedition auf dem Schiff *Valdivia* 1898–1899. (VII. Internationaler Geographen-Kongress, Berlin, 1899.) Size 10 × 7, pp. 120. *Maps, Diagram, etc.*

Oceanography—Red Sea. *Sitzb. A.W. Wien* **107**, Abth. 1 (1898): 609–637. **Luksch.**

Vorläufiger Bericht über die physikalisch-oceanographischen Untersuchungen im Rothen Meere, 6 September 1897 bis 24 März 1898. Von Josef Luksch. *With Map.*

Oceanography—Strait of Dover. **Moore.**

Report on Observations of the Tidal Currents and Undercurrents in the Strait of Dover made with a Deep-Sea Current Meter. By Captain W. Usborne Moore, R.N., H.M.S. *Research*, 1896. London: J. D. Potter, 1899. Size 13½ × 8½, pp. 18. *Chart. Price 3s. Presented by the Hydrographic Office, Admiralty.*

Zoogeography. *Sitzb. A.W. Wien* **107**, Abth. 1 (1898): 1057–1170. **Vierhapper.**

Zur Systematik und geographischen Verbreitung einer alpinen *Dianthus*-Gruppe. Von F. Vierhapper, jun. *With Map and Plates.*

ANTHROPOGEOGRAPHY AND HISTORICAL GEOGRAPHY.

Ancient Empires. **Maspero.**

G. Maspero. Histoire ancienne des Peuples de l'Orient Classique. I. Les origines, Egypte & Chaldée (1895); II. Les premières mêlées des Peuples (1897); III. Les Empires (1899); Paris, Hachette et Cie. Size 11½ × 8, pp. (I.) 804; (II.) 798; (III.) 826. *Maps and Illustrations.*

A massive contribution to our knowledge of the empires of the lands bordering on the Eastern Mediterranean and the Persian gulf in the earliest times.

Anthropogeography. **Körösy.**

Zur internationalen Nomenclatur der Todesursachen. Kritische Bemerkungen zu Dr. Bertillon's Vorschlägen. Von Dr. Josef von Körösy. Berlin: Puttkammer & Mühlbrecht, 1899. Size 10 × 7, pp. 42. *Presented by the Author.*

On an international classification of the causes of death for use in the compilation of vital statistics.

Anthropogeography. **Kiær.**

Projet d'explorations démographiques à exécuter dans des pays inconnus. Par. M. A. N. Kiær. Kristiania, 1899. Size 10 × 6½, pp. 12. *For private circulation.*

Proposals for carrying out census enumerations in parts of the world not yet under the complete control of civilized governments. The proposal originated at the St. Petersburg Statistical Congress in 1898, and was supported at the Berlin Geographical Congress in 1899. It will, we believe, be further discussed at one of the Paris Congresses this year.

Commercial Geography.

The World's Commerce and the United States' share of it. Second Edition. Philadelphia: Commercial Museum, 1899. Size 8½ × 4, pp. 16.

Commercial Geography. *Contemporary Rev.* **76** (1899): 371–378. **Bowles.**

The Sea the Only Road for Trade. By T. G. Bowles, M.P.

Commercial Geography. *G.Z.* **6** (1900): 10–20. **Halle.**

Die klimatische Verteilung der Industrie. Von Prof. Dr. Ernst von Halle.

Commercial Geography—Tea. **McEwan.**

VII. Internationaler Geographen-Kongress, Berlin, 1899. The Geography of Tea. By John McEwan. Size 8½ × 4½, pp. 20. *Presented by the Author.*

Historical. **Gallois.**

Terzo Congresso Geografico Italiano. Améric Vespuce et les Géographes de Saint-Dié. Mémoire de M. L. Gallois. Firenze: M. Ricci, 1899. Size 9½ × 7, pp. 16. *Presented by the Author.*

Historical. **Partsch.**

Die geographische Arbeit des 19 Jahrhunderts. Rede gehalten beim Antritt des Rectorats der Universität Breslau am 15 October 1899. Von Professor Dr. Josef Partsch. Breslau: W. G. Korn, 1899. Size 9 × 6, pp. 18.

On the geographical work accomplished during the nineteenth century.

Historical Geography. *G.Z.* **5** (1899): 665–671. **Kretschmer.**

Die Beziehungen zwischen Geographie und Geschichte. Vortrag, gehalten auf dem VII. internationalen Geographen-Kongress zu Berlin. Von Konrad Kretschmer.

Historical—Kepler. **Pixis.**

Kepler als Geograph, eine historisch-geographische Abhandlung von Rudolf-Pixis. (Münchener Geographische Studien, herausgegeben von Siegmund Günther. Sechstes Stück.) München: T. Ackermann, 1899. Size 9½ × 6, pp. viii and 142. *Price 2s. 6d.*

A study of Kepler's views on physical geography based ultimately on the eight-volume edition of the collected works, and on subsequently published correspondence.

Migrations. *Globus* **76** (1899): 377–380. **Dix.**

Ein Jahrhundert der überseeischen Völkerwanderung. Von Arthur Dix.

The number of emigrants from Europe by sea during the nineteenth century is estimated in round numbers as 30,000,000.

Political Geography. **Léotard.**

Conférence de M. Jacques Léotard sur les Compétitions Européennes au Soudan et en Chine faite le 6 Avril 1899 à l'Association Amicale des Anciens Élèves de l'École Supérieure de Commerce. Marseilles. Size 10 × 6½, pp. 8. *Presented by the Author.*

Universal History. **Helmolt and others.**

Weltgeschichte. Erster Band. Allgemeines—Die Vorgeschichte—Amerika—Der Stille Ozean. Von Dr. Hans F. Helmolt, Prof. Dr. Josef Kohler, Prof. Dr. Friedrich Ratzel, Prof. Dr. Johannes Ranke, Prof. Dr. Konrad Haebler, Eduard Graf Wilczek und Dr. Karl Weule. Leipzig und Wien: Bibliographisches Institut, 1899. Size 10½ × 7, pp. x. and 630. *Maps and Illustrations.*

This is the first volume of a treatise on the history of the world from the standpoint of the development in culture of the human race. It contains a general account of the prehistoric period, and sketches in some detail the history of America and of the Pacific ocean from the earliest times to the present day.

BIOGRAPHY.

Bandelier. **Ballivián.**

Mr. Adolfo F. Bandelier y sus Investigaciones en el Continente Americano. Por Manuel Vicente Ballivián. La Paz, 1899. Size 9 × 6½, pp. 20. *Presented by the Author.*

Barbier. **Pfister.**

Joseph-Victor Barbier. Notice sur sa vie et ses travaux. Par Ch. Pfister. Nancy [not dated]. Size 9 × 5½, pp. 38. *Portrait. Presented by the Société de Géographie de l'Est, Nancy.*

Baumann. *Deutsche Rundschau G.* **22** (1900): 231–233. ———

Dr. Oskar Baumann. *With Portrait.*

Dr. Baumann was born in Vienna in 1865, and, after having taken a great part in the exploration of East Africa, died last year.

Biographical Dictionary. ———

Who's who, 1900. An annual Biographical Dictionary. Fifty-second year of issue. London: A. & C. Black, 1900. Size 7½ × 5, pp. xviii. and 1092. *Presented by the Publishers.*

This convenient handbook of brief biographies of living persons is fast becoming indispensable, although there is room for the inclusion of some additional geographers and travellers.

Camperio. *B.S.G. Italiana* **1** (1900): 142–154. **Biessich.**

Manfredo Camperio. Cenni necrologici del socio Aldo Biessich.

Fisher. *Geolog. Mag.* **7** (1900): 49–54. **Davison.**

Eminent Living Geologists: Rev. Osmond Fisher, M.A. By C. Davison. *With Portrait.*

The author of 'Physics of the Earth's Crust.'

Hazen. *Science* **11** (1900): 222–223. ——

Professor Henry Allen Hazen.

This notice of Prof. Hazen, the American meteorologist, is printed from advance sheets of the *Monthly Weather Review*.

Humboldt. *Z. Ges. Erdk. Berlin* **34** (1899): 311–362. **Lentz.**

Alexander von Humboldt's Aufbruch zur Reise nach Süd-Amerika. Nach ungedruckten Briefen A. v. Humboldt's an Baron v. Forell dargestellt von Eduard Lentz.

Kropotkin. ——

Memoirs of a Revolutionist. By P. Kropotkin. With a Preface by George Brandes. 2 vols. London: Smith, Elder & Co., 1899. Size 8½ × 5½, pp. (vol. i.) xiv. and 258; (vol. ii.) 340. *Portraits. Price* 21*s*.

In these volumes Prince Kropotkin publishes for the first time in the English language a short but clear description of his travels in Siberia while an officer in the Russian army, and explains how he was led to form the theory of the mountain system of Asia which is now universally accepted. He also furnishes an account of his studies of the physical geography of Finland, and the first volume contains so much geography that 'Memoirs of a Geographer' would form an appropriate title.

Rawson. *J.R. Statistical S.* **62** (1899): 677–679. ——

Sir Rawson W. Rawson.

Schmitt. *Deutsche Rundschau G.* **22** (1899): 135–137. ——

Robert Hans Schmitt. *With Portrait.*

GENERAL.

Almanac. ——

Annuaire pour l'an 1900, publié par le Bureau des Longitudes. Avec des notices scientifiques. Paris: Gauthier-Villars. Size 6 × 4, pp. vi., 628, 90, 16, 8, 2, 20, and 38.

In this issue hours are given in the *Annuaire* for the first time in the notation of 0^h to 24^h, starting from midnight.

Anthropogeography—Towns. **Thomson.**

P. and T.R.G.S. Australasia, Queensland **14** (1899): 1–8.

The Geographical Conditions of City Life. By J. P. Thomson.

Astronomy. **Downing.**

Precession Tables adapted to Newcomb's value of the Precessional Constant and reduced to the epoch 1910·0. By A. M. W. Downing, D.SC., etc. Edinburgh, 1899. Size 12½ × 10, pp. 86. *Presented by the Author.*

Astronomy. **Rambaut.**

On the Orbit of the part of the Leonid Stream which the Earth encountered on the morning of 1898, November 15th. By Arthur A. Rambaut, D.SC. (From the *Proceedings of the Royal Society*, vol. 65.) Size 8½ × 5½, pp. 321–328. *Presented by the Author.*

Bibliography. *P. and T.R.G.S. Australasia, Queensland* **14** (1899): 12–25. ——

Some Critical Notes on the Queensland Volume of the International Catalogue of Scientific Literature.

This report by the Council of the Brisbane branch of the Royal Geographical Society of Australasia apparently led to a correspondence with those responsible for the catalogue which was criticized; but while the letters of the Council are printed in an appendix, the replies have not been published.

Bibliography. **Fanchiotti.**

G. Fanchiotti. I Mss. Italiani in Inghilterra. Serie I. Londra. Il Museo Britannico. Vol. i. La Collezione Sloane. London, 1899. Size 11 × 7½, pp. 164.

On the Italian manuscripts in the Sloane Collection in the Library of the British Museum.

Bibliography—Catalogue. ——

Verzeichnis der Bücher in der Bibliothek der K. K. Geographischen Gesellschaft in Wien. Nach dem Stande vom 15 December 1897. Mit Nachtragen bis 31 December 1898. Wien, 1899. Size 9 × 6, pp. 450. *Presented by the K. K. Geographischen Gesellschaft, Wien.*

This catalogue of the Vienna Geographical Society is arranged under a comparatively small number of subject-headings in a series of lists, each of which runs

alphabetically, according to authors' names. The whole is brought together in a continuous authors' index.

Bibliography—English Catalogue. ——

The English Catalogue of Books for 1899. Giving Titles Classified under Author and Subject in one Strict Alphabet, with particulars of Size, Price, Month of Publication, and Name of Publisher of the Books issued in Great Britain and Ireland in 1899, and the principal books published in America. London: Low & Co., 1900. Size 10½ × 6½, pp. 248.

Book of Reference. **Janes.**

The Englishwoman's Year Book and Directory, 1900. Second Year of New Issue. Edited by Emily Janes. London: A. & C. Black, 1900. Size 7½ × 5, pp. xxii. and 340. *Presented by the Publishers.*

British Empire. *P. Lit. and Philosoph. S. Liverpool* 53 (1899): 153–169. **Philip.**

The Growth of Greater Britain. A Review and a Forecast. By George Philip, jun. *With Map.*

The map shows by appropriate colours the gradual growth of the British empire and its territorial extent at different periods.

Education. **Zubiaur and Spilsbury.**

La Educacion Industrial. Informes sobre la Educación Industrial en los Estados Unidos de Norte-América y paises Europeos, publicados en Inglés bajo la dirección del Sr. Carrol D. Wright. Traducidos al Castellano por el Dr. J. B. Zubiaur y el Rev. Dr. J. H. Gybbon Spilsbury. Buenos Aires, 1899. Size 9½ × 6½, pp. 450.

Educational. **Ebner.**

200 farbige Skizzen (meist Tafelzeichnungen) zur Einführung in den Geographie-Unterricht. Für Lehrer und Schüler an Bürger- und Mittelschulen. Von Prof. Dr. H. Ebner. Wien und Leipzig: G. Freytag & Berndt [*not dated*]. Size 8 × 5½, pp. 72. *Presented by the Publishers.*

A collection of coloured diagrams, partly concerned with map-drawing, but mainly with statistics of various kinds.

Educational—Methods. *G.Z.* 6 (1900): 20–27. **Ratzel.**

Die Lage im Mittelpunkt des geographischen Unterrichtes. Von Friedrich Ratzel.

Educational—Methods. *J. School G.* 3 (1899): 368–375. **Snyder.**

Geographical Laboratory Work in Worcester Academy, Worcester, Mass. By W. H. Snyder.

Describes the series of exercises in practical geography carried out in the Physical Geography Laboratory of Worcester Academy. The exercises deal chiefly with the use of contour maps, drawing sections from maps, simple determinations of latitude and projections. The meaning and use of meteorological maps is also taught.

English Dictionary. ——

A Standard Dictionary of the English Language upon Original Plans, designed to give, in complete and accurate statement, . . . the Orthography, Pronunciation, Meaning, and Etymology of all the words and the meaning of Idiomatic Phrases in the Speech and Literature of the English-speaking Peoples. Prepared by more than Two Hundred Specialists and other scholars, under the supervision of Isaac K. Funk, D.D., LL.D., Francis A. March, LL.D., Daniel S. Gregory, D.D., LL.D. 2 vols. Vol. i., A to L; vol. ii., M to Z. New York and London: Funk & Wagnall's Co., 1900. Size 13 × 9½, pp. xx. and 2318. *Maps, Illustrations, and Coloured Plates. Presented by Dr. I. K. Funk.*

This very profusely illustrated dictionary is accompanied by a short gazetteer, which has not been uniformly revised to date, and a number of maps coloured politically, and produced in the familiar style of American atlases.

Geographical Congress. *Naturw. Wochenschrift* 14 (1899): 501–508. ——

VII. Internationaler Geographen-Congress Berlin, 28 September bis 4 Oktober 1899.

German Colonies. ——

Jahresbericht über die Entwickelung der Deutschen Schutzgebiete im Jahre 1898–1899. (Beilage zum Deutschen Kolonialblatt 1900.) Berlin: E. S. Mittler und Sohn, 1900. Size 12 × 9, pp. 318.

Rumanian Geographical Society.

Notice sur la Société Roumaine de Géographie (1875–1900). Bucarest: J. V. Socecŭ, 1899. Size 9¼ × 6½, pp. 24.

Travel. **Jefferson.**

A New Ride to Khiva. By Robert L. Jefferson. London: Methuen & Co., 1899. Size 8 × 5¼, pp. xii. and 312. *Illustrations. Price* 6*s. Presented by the Publishers.*

The narrative of a cycle ride across Germany, Austria, Hungary, South Russia, and the Kirghiz steppe to Khiva. The cyclist was obliged to make use of camels in crossing the desert. The whole journey was a remarkable feat of endurance, and contains more of geographical interest than is usual in such works.

NEW MAPS.

By J. COLES, *Map Curator*, R.G.S.

EUROPE.

England and Wales. **Ordnance Survey.**

Publications issued since February 8, 1900.

6-inch—County Maps:—

ENGLAND AND WALES (revision):—**Cheshire**, 7 S.E., 45 N.E., 59 N.E., 64A N.E., 64 N.W., 65 N.W., S.E. **Derbyshire**, 21 S.E. **Staffordshire**, 1 S.E. **Westmorland**, 24 S.W., 25 N.W. 1*s. each.*

25-inch—Parish Maps:—

ENGLAND AND WALES (revision):—**Berkshire**, XII. 3, 7, 12; XIV. 9, 13, 14; XV. 14; XVII. 7, 8; XVIII. 3, 4; XXXIII. 2, 7, 8, 10, 11, 12; XXXV. 13. **Bucks**, XIII. 12, 13, 16; XIV. 7, 10, 11; XV. 2, 9, 11, 12, 13, 15; XVII. 12, 16; XVIII. 2; XIX. 1; XX. 6, 16. **Cumberland**, XXXV. 8; XLVII. 13; LIV. 8, 12; LV. 4, 5; LVI. 1; LVIII. 5, 13, 14; LXI. 2, 3. **Derbyshire**, XXXIV. 14; XXXV. 13; XXXVII. 8, 12; XXXVIII. 6, 9; XLII. 12, 15, 16. **Denbighshire**, I. 14 and 15; III. 3, 7, 8, 11, 12, 15, 16; IV. 13; VI. 4, 7, 8; VII. 1, 2, 3, 5, 6, 7, 8, 9, 10, 12, 13, 14, 16; XI. 16; XII. 1, 2, 3, 6, 8, 9, 10, 11, 13, 14, 15, 16; XVI. 4; XVII. 1, 5, 11; XX. 6; XXIV. 1, 2, 3, 7, 8, 9, 10, 11, 13, 14, 16; XXV. 5, 9, 10, 11, 12, 14; XXVI. 5; XXXI. 1, 2, 4, 11; XXXII. 1, 2, 7; XXXIII. 2, 6; XXXV. 2; XXXIX. 10. **Glamorganshire**, XI. 6; XVIII. 5, 13; XXVII. 8; XXXVI. 2, 3, 4, 5, 6, 7, 15; XLII. 10, 14, 16; XLV. 1, 2, 3, 4, 7, 8, 9, 11, 12; XLVI. 1, 3, 5, 7. **Nottinghamshire**, IX. 11, 13, 16; XV. 2, 4, 6, 7, 14; XVI. 3, 4, 16; XX. 3, 5, 7, 8, 9, 11, 12, 13, 15; XXI. 2, 5, 6, 7, 9, 10; XXIV. 1, 2, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; XXV. 1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14; XXVI. 1, 5, 6, 9, 10, 14. **Northamptonshire**, LXVI. 13; LXVII. 1. **Oxfordshire**, IX. 16; XI. 12, 14, 15; XIII. 12; XIV. 4, 7, 9, 10, 11, 13, 14; XV. 1, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 15, 16; XVI. 1, 4, 5, 6, 7, 8, 9, 11, 12, 13, 15, 16; XVII. 1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16; XXI. 4; XXII. 2, 3, 4; XXIII. 10; XXXIII. 15; XXXIX. 8. **Staffordshire**, XIV. 12, 14; XV. 9; XVIII. 4, 12; XIX. 4, 8, 12; XX. 12, 15. **Wiltshire**, III. 7, 8, 10, 11, 12, 14, 15, 16; IV. 7, 8, 10, 12, 13, 14, 15; V. 9, 13, 16; VI. 6, 9, 11, 13, 15; VIII. 1, 2, 3, 4; IX. 8, 12, 14, 15; X. 1, 2, 3, 5, 9; XI. 1, 3, 5, 7; XVI. 2, 3, 4, 6, 7, 8, 10, 11, 12, 14, 15, 16; XXIII. 2, 3, 4, 7, 10, 11, 12; XXX. 2, 6, 7, 9, 10, 11. 3*s. each.*

Miscellaneous:—County Diagrams, scale 2 miles to 1 inch, printed in colours, showing unions, sanitary districts, boroughs, and civil parishes; also the $\frac{1}{2500}$ scale sheet lines, viz. Cambridgeshire, Cardiganshire, Montgomeryshire, and Oxfordshire. *Price* 3*s. each.*

(E. Stanford, Agent.)

Historical Atlas. **Poole.**

Historical Atlas of Modern Europe, from the Decline of the Roman Empire; comprising also parts of the New World connected with European History. Edited by Reginald Lane Poole, M.A., PH.D., Fellow of Magdalen College, and Lecturer in Diplomatic, in the University of Oxford. Part XXV. Oxford: the Clarendon Press; London, Edinburgh, Glasgow, and New York: Henry Frowde, M.A.; Edinburgh: W. & A. K. Johnston. 1900. *Price* 3*s.* 6*d. Presented by the Clarendon Press.*

The present issue of this Atlas, Part XXV., contains the following maps: No. 40,

Germany at the Peace of Westphalia, 1648, by the Rev. J. P. Whitney, M.A.; No. 59, the French Empire in 1810, by H. A. L. Fisher, M.A.; and No. 88, The United States of America after the treaty of 1783, by Hugh E. Egerton, M.A. Each map is accompanied by explanatory letterpress.

Portugal. **Portuguese Government.**

Portugal. Scale 1: 100,000 or 1·6 stat. mile to an inch. Sheets: 2, Larouco; 5, Chaves; 36, Quinta. Levantada construida e gravada pela Direcção Geral dos trabalhös geodesicos e topographicos, Publicada em 1898, 1899.

ASIA.

Asia. **Service Géographique de l'Armée, Paris.**

Asie. Scale 1: 1,000,000 or 15·8 stat. miles to an inch. Sheets: Kang Neung, Pékin, Moukden, Tcheng-Te-Fou, Vladivostok, Nankin, Quelpaërt, Séoul. Dessiné, heliogravé et publié par le Service Géographique de l'Armée, Paris. *Price* 1·25 *fr. each sheet.*

As will be seen by the title, these sheets include those parts of China, Russia, and Korea with regard to which a great deal of political interest is felt at the present time. The map is very nicely drawn, soundings are given along the coast, and all means of communication are shown.

China. **Riddel.**

Map of the Neighbourhood of Swatow, from Pheng-Hai in the south-west to Chau-An on the east, and Yung-Ting in the north, with the course of the North Han to Ting-Chow and West Han to Moi-lim. Scale 1: 63,360 or 1 mile to an inch. By Rev. W. Riddel, M.D. London: McCorquodale, 1899. 12 sheets.

In this map the coast-line is taken from the Admiralty charts, and the chief inland positions are fixed by plane-table or sextant, the details being filled in with prismatic compass. The names of district cities are given in Mandarin Chinese, with local name underneath. Where names would be crowded, numbers have been used, beginning and ending in each 5-mile square, the position of which in each degree is marked by numbers at sides of the sheets, in order to find names by an index. A full explanation is given of the symbols used in the map.

The map is a lithographic facsimile of the original drawing by Dr. Riddel.

AFRICA.

South Africa. **Johnston.**

Special Map to illustrate the Military Operations in South Africa, 1900. W. & A. K. Johnston, Edinburgh & London. *Price* 1*s.*, *coloured.*

Tunis. **Service Géographique de l'Armée, Paris.**

Carte topographique de la Tunisie. Scale 1: 50,000 or 0·8 stat. mile to an inch. Sheet lxxiii., Kerker. Dressé, heliogravé et publié par le Service Geographique de l'Armée, Paris. *Price* 1.50 *fr.*

West Africa. **"La Dépêche Coloniale."**

Gouvernement Général de la Cote Occidentale d'Afrique. Scale 1: 4,000,000 or 63 stat. miles to an inch. "La Dépêche Coloniale," Lundi 12 Février 1900. Paris.

AMERICA.

North-West Canada. **Surveyor-General's Office.**

Map of Parts of the Yukon Territory and Mackenzie District. Scale 1: 1,267,200 or 20 stat. miles to an inch. Surveyor-General's Office, Ottawa, 1899. *Presented by the Surveyor-General of Canada.*

Mr. W. Thibaudeau has compiled this map, under Mr. Ogilvie's direction, from all the most recent sources of information, which are acknowledged in a note. The object of the map is to show the course of the Peel river and its tributaries. It has been printed for the use of the Survey Office only, and is not intended for public distribution. There is no hill shading, but the supposed line of watershed between the Yukon and Mackenzie basins is laid down.

AUSTRALIA.

Western Australia. **Campbell.**

Topographical Map of Menzies, North Coolgardie Gold Field. Scale 4 inches to a mile. By W. D. Campbell, Topographical Surveyor, 1899. Geological Survey

Office, Perth, Western Australia. *Presented by A. Gibb Maitland, Esq., Government Geologist.*

Western Australia. **Geological Survey Office, Perth.**

Geological Sketch-Map of the country between Cue, Peak Hill, and Menzies. Scale 1 : 1,500,000 or 23·6 stat. miles to an inch. Geological Survey Office, Perth. *Presented by A. Gibb Maitland, Esq., Government Geologist.*

GENERAL.

Exploration. **Schrader.**

L'Année Cartographique. Supplément Annuel à toutes les Publications de Géographie et de Cartographie. Dressé et rédigé sous la direction de F. Schrader. Neuviéme Supplément, contenant les Modifications Géographiques et Politiques de l'Année, 1898. Paris: Librairie Hachette et Cie., 1900. *Price 3 fr.*

The first sheet of this useful atlas contains maps showing the route followed by Captain Welby and Lieut. Malcolm across Northern Tibet in 1896; a map of Formosa based on the Japanese maps published by the Geographical Society of Tokio; maps showing the routes followed by Mr. Cl. Madrolle in Yunnan, Se-Chuan, Hai-nan, and the Lei-Chau peninsula. There is also a map on which Mr. A. H. Savage Landor's route to the sources of the Brahmaputra is laid down. The African sheet contains a map showing Mr. E. Gentil's explorations between the Ubangi and Lake Chad; the frontier region between Liberia and the French possessions on the Ivory Coast; the region of the Bhar-el-Ghazal, on which the routes followed by the Marchand expedition during the years 1897–98–99 are laid down; the journey of Mr. L. Derragon between Jibuti and Addis-Ababa; and a map of the north-western portion of Madagascar, showing the explorations of Lieut. Duruy. On the American sheet are the following maps: Part of Central America, from the map of Dr. C. Sapper; a railway map of Argentina and Uruguay; and a map of the Andine Region of Argentine Patagonia, from unpublished documents furnished by Dr. F. P. Moreno. Each sheet of this atlas is accompanied by explanatory letterpress.

World. **Langhans.**

Deutsche Flotten-Wandkarte zur Veranschaulichung deutscher See-Geltung und See-Geschichte. Bearbeitet von Paul Langhans. Gotha: Justus Perthes. 8 sheets. *Price, in sheets, 16 marks.*

This map is intended to illustrate German naval history. German possessions are coloured red, principal railways and steamship routes are shown, and German naval stations clearly indicated; in addition to this, a great deal of information is given in tabular form.

World. **Vivien de Saint-Martin and Schrader.**

Atlas Universel de Géographie. Ouvrage commencé par M. Vivien de Saint-Martin et continué par Fr. Schrader. Sheet 42, Asie Physique. Paris: Librairie Hachette et Cie. *Price 2 fr.*

This is the last-published sheet of the Atlas Universel. It is coloured in fifteen different shades to indicate the elevations of the land and the depths of the ocean, which are also given in figures. The relief is also shown by hill shading, and, considering the small scale of the map, a large amount of detail is given.

CHARTS.

Russian Charts. **Chief Hydrographic Department, Ministry of Marine, St. Petersburg.**

Charts and Plans published by the Chief Hydrographic Department, Ministry of Marine, St. Petersburg.

Black Sea.

No.
542. Plan of Varna. Scale 2240 feet to an inch. 1899.
533. Plan of Burghaz harbour. Scale 4550 feet to an inch. 1899.
530. Plan of the Kilia mouths of the Danube. Scale 5150 feet to an inch. 1899.
535. Eupatoria bay. Scale 700 feet to an inch. 1899.
544. Plan of Dniester bay. Scale 0·9 stat. mile to an inch. 1899.

North Pacific Ocean.

1812. Plan of Possiet bay. Scale 4550 feet to an inch. 1899.

United States Charts. **U.S. Hydrographic Office.**

Pilot Chart of the North Atlantic Ocean for February, 1900. Published at the Hydrographic Office, Washington, D.C. *Presented by the U.S. Hydrographic Office.*

PHOTOGRAPHS.

Canadian Rocky Mountains. **Wilcox.**

Five Picturesque Landscapes in the Canadian Rocky Mountains. By Walter D. Wilcox, Esq., F.R.G.S. New York and London: G. B. Putnam's Sons, 1900. *Presented by W. D. Wilcox, Esq., F.R.G.S.*

These are a very beautiful set of photographs of some of the most picturesque scenery of the Canadian Rocky mountains. The following is the list of their titles:—

(1) At the foot of the Rockies; (2) Moraine lake; (3) Lake Aline; (4) Mount Assiniboine; (5) Evening.

New Guinea and Pacific Islands. **Brown.**

Fifty-two Photographs of British and German New Guinea, New Britain, and Solomon Islands. By Rev. G. Brown, D.D. *Presented by Rev. G. Brown, D.D.*

Although the circumstances under which these photographs were taken by Dr. George Brown must at times have made his task a difficult one, he has nevertheless succeeded in producing remarkably good specimens. The selection of subjects has been carefully made to illustrate the scenery and natives, together with their dwellings, implements, etc. The titles are as follows:—

British New Guinea.—(1) London Missionary Society station, Port Moresby; (2) View from mission house, Port Moresby; (3) Street in Port Moresby; (4) Street in Port Moresby; (5) Street, Elevara island, Port Moresby; (6) Elevara island, Port Moresby; (7) New Guinea stone clubs; (8) Women coming from work; (9) School-girls at mission station, Dobu; (10) Three schoolboys, Dobu; (11) Native houses, Dobu; (12, 13) Part of circular village, Fergusson island; (14) Women and girls, Dobu; (15) Women, Normanby island; (16) Women cooking, Normanby island; (17) Group of natives, Normanby island; (18) Natives, Normanby island.

German New Guinea.—(19) Group of natives; (20) Women and children; (21, 22) Women; (23–26) Natives; (27) Man in the act of shooting.

New Britain.—(28) Native village; (29, 30) Native dances; (31) Fijian dance.

Solomon Islands.—(32) Natives, Shortland group; (33) Tambu house, Shortland group; (34) House and natives, Rubiana, New Georgia; (35) Canoe, Rubiana, New Georgia; (36) Canoe and wooden figure, Rubiana, New Georgia; (37) Sacred image in bush, Rubiana, New Georgia; (38, 39) Figure showing distension of lobe of the ear, Rubiana, New Georgia; (40) Gemu, chief of Rubiana, New Georgia; (41) Man and women, Rubiana, New Georgia; (42) Burial-place, Rubiana, showing miniature house in which the skull of dead relatives is placed; (43, 44) Natives of Shortlands group; (45) Village, Aola; (46, 47) Village scene, Marau, Guadalcanar; (48) Beach scene, Florida; (49) Two natives, Marau; (50) Three men and boy, Marau; (51) Women and children, Marau; (52) Head hunter's canoe, Marau.

Vancouver Island. **Victoria Book and Stationery Co.**

Photographic View Album of Picturesque Victoria, Vancouver Island. Published by Victoria Book & Stationery Co., Victoria, B.C. *Presented by Lieut. Tristan Dannreuther, R.N.*

The titles are given below:—

(1) Looking from the new Government buildings, James bay, Victoria; (2) James bay, from cathedral; (3) James bay, looking west from cathedral; (4, 5) Parliament buildings, Victoria; (6) East side, Parliament buildings; (7) Government street; (8) Post Office; (9) St. Anne's convent; (10, 11) Beacon hill park; (12) Mount Baker, from Victoria; (13) Esquimalt church and royal roads; (14) H.M. ships in Esquimalt harbour; (15) Outer harbour; (16) Olympic range, from Victoria; (17) The Gorge, Victoria Arm; (18) Naval canteen grounds, Esquimalt; (19) St. Andrew's Presbyterian church, Metropolitan Methodist church, Roman Catholic church; (20) Salmon run, near Yale; 30,000 Fraser river salmon; (21) A catch of trout before breakfast; Sproats falls, Alberni district, V.I.; (22) Sporting views in the neighbourhood of Victoria.

N.B.—It would greatly add to the value of the collection of Photographs which has been established in the Map Room, if all the Fellows of the Society who have taken photographs during their travels, would forward copies of them to the Map Curator, by whom they will be acknowledged. Should the donor have purchased the photographs, it will be useful for reference if the name of the photographer and his address are given.

BATHYMETRICAL SU

PLATE II

BY SIR JOHN MURRAY, K.C.

The Edinburgh Geographical Institute

Publis

SURVEY OF THE SCOTTISH LOCHS.

K.C.B., LL.D., F.R.S., AND FRED. P. PULLAR, F.R.G.S.

THE GEOGRAPHICAL JOURNAL 1900

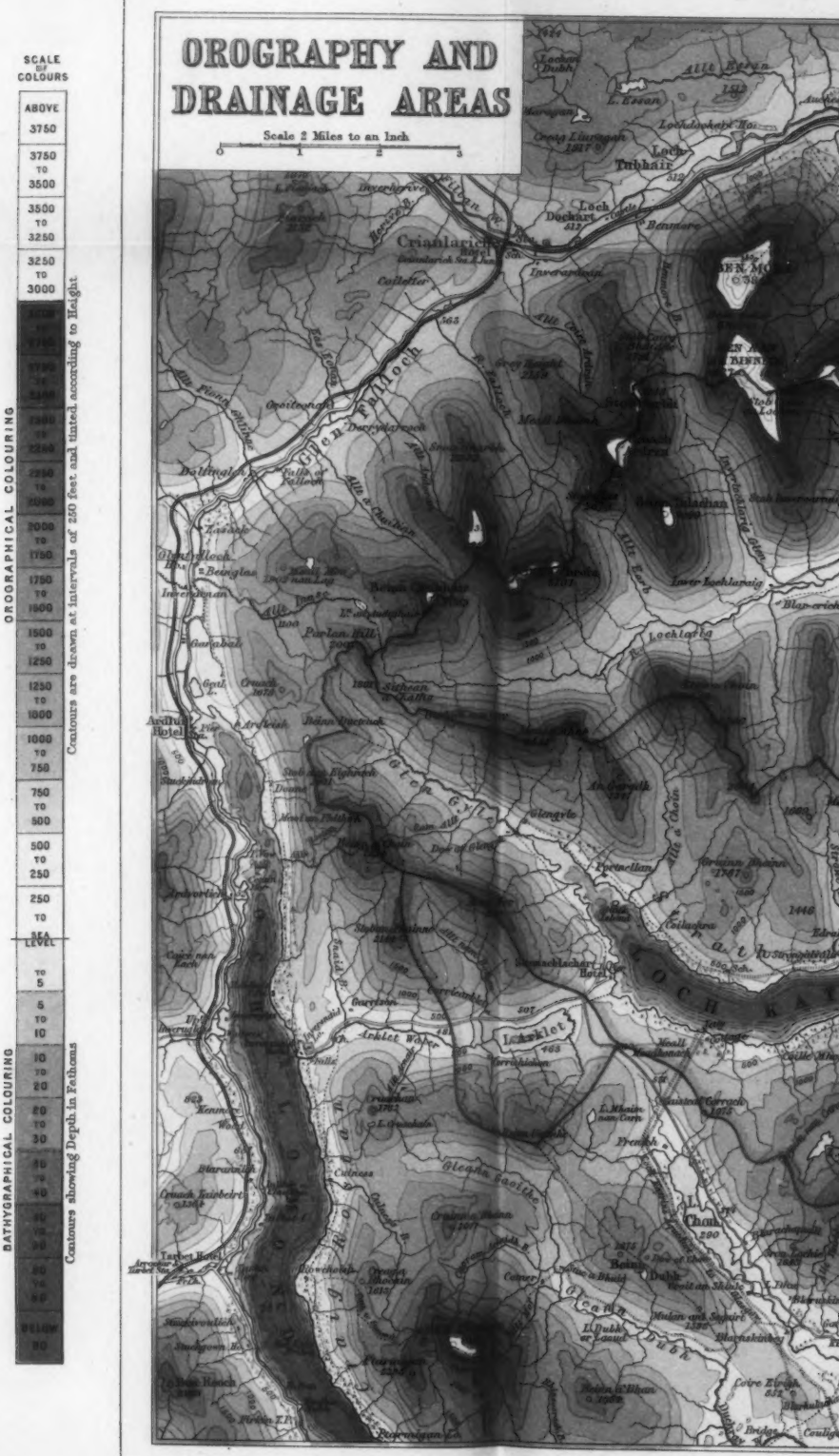
Published by the Royal Geographical Society.

J.G.Bartholomew.

BATHYMETRICAL S

BY SIR JOHN MURRAY, K

PLATE I



The Edinburgh Geographical Institute

Publi

Survey of the Scottish Lochs.

Y. K.C.B., LL.D., F.R.S., and FRED. P. PULLAR, F.R.G.S.

Published by the Royal Geographical Society.

J. G. Bartholomew.

MEAN ANNUAL RAINFALL

Scale 2 Miles to an Inch

0 1 2 3

SCALE OF RAINFALL COLOURING

INCHES			M. M.		
under	50		under	1270	
50	to	60	1270	to	1524
60	.	70	1524	.	1778
70	.	80	1778	.	2032
80	.	90	2032	.	2286
90	.	100	2286	.	2540
100	.	110	2540	.	2794
over		110	over		2794

SURVEY OF THE SCOTTISH LOCHS.

RAY, K.C.B., LL.D., F.R.S., AND FRED. P. PULLAR, F.R.G.S.

THE GEOGRAPHICAL JOURNAL 1900

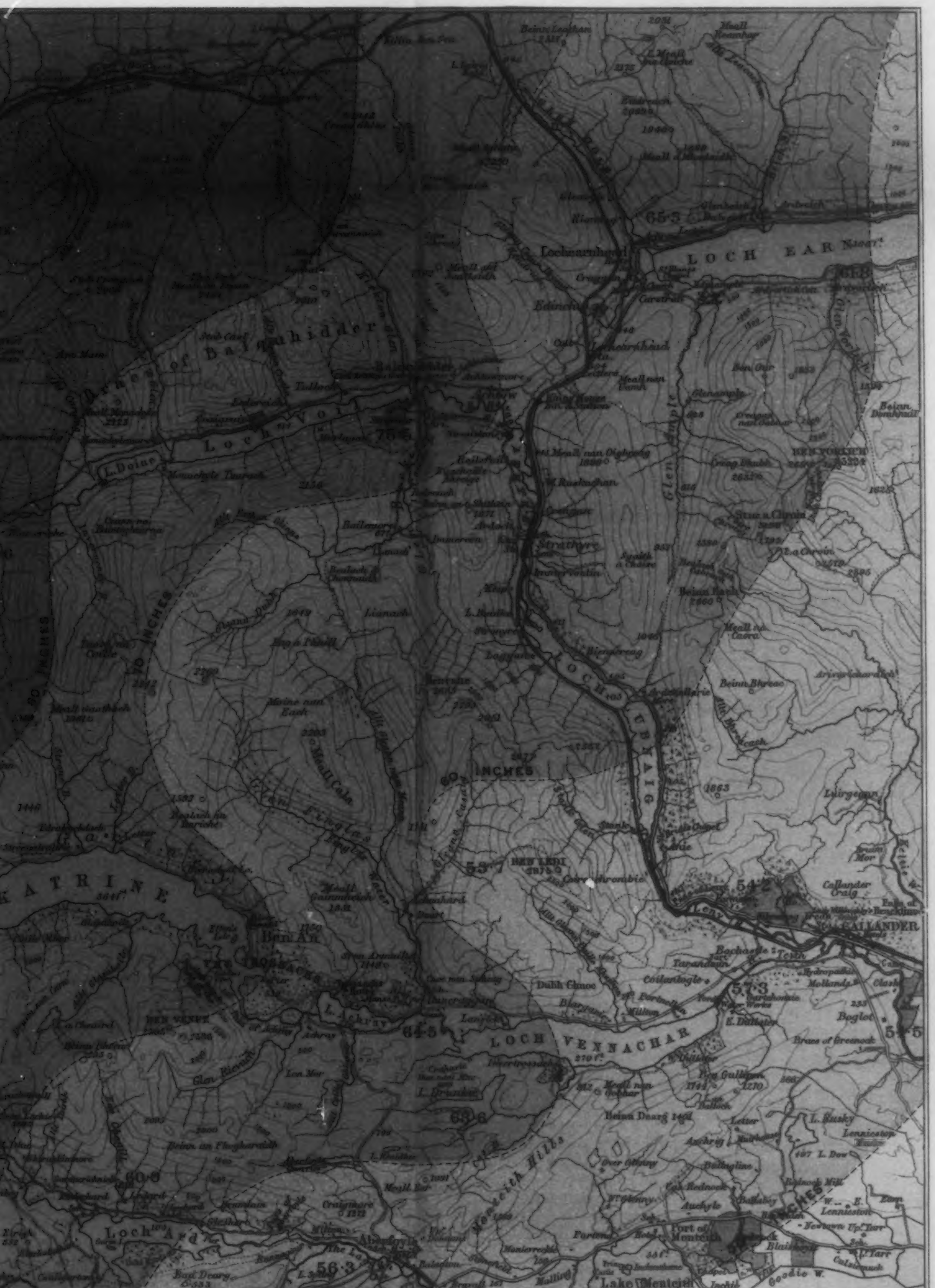


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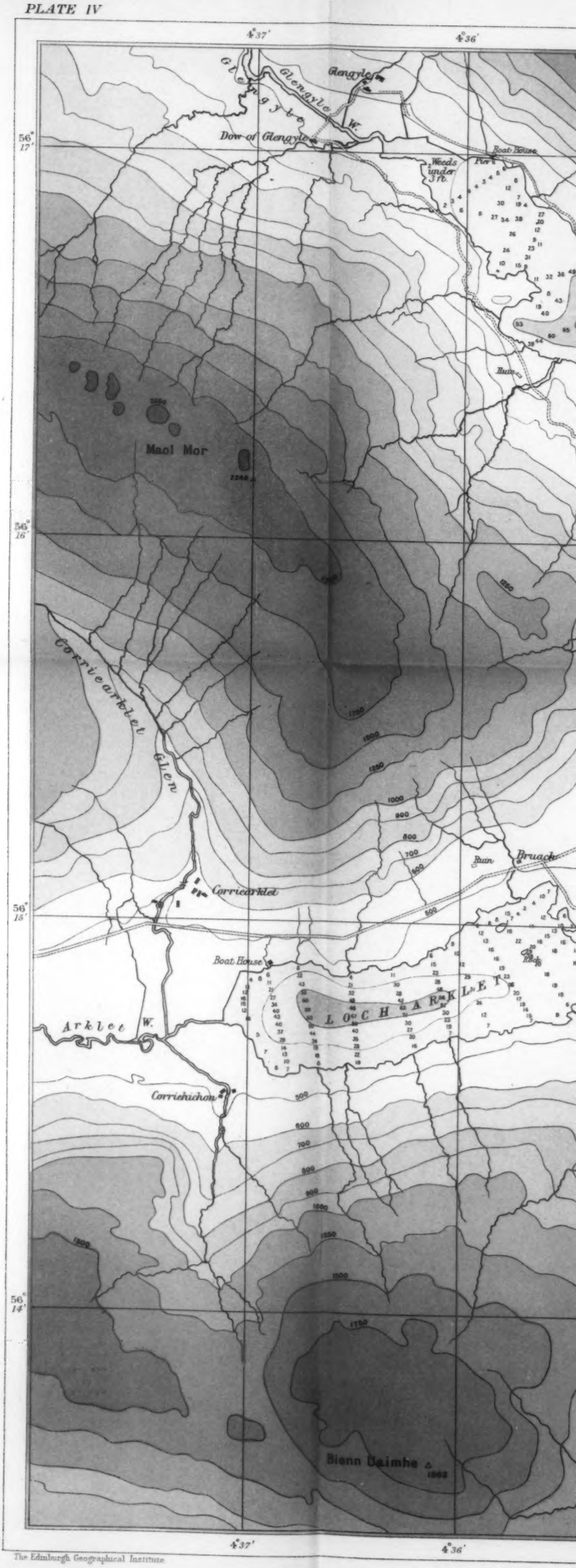
PLATE IV



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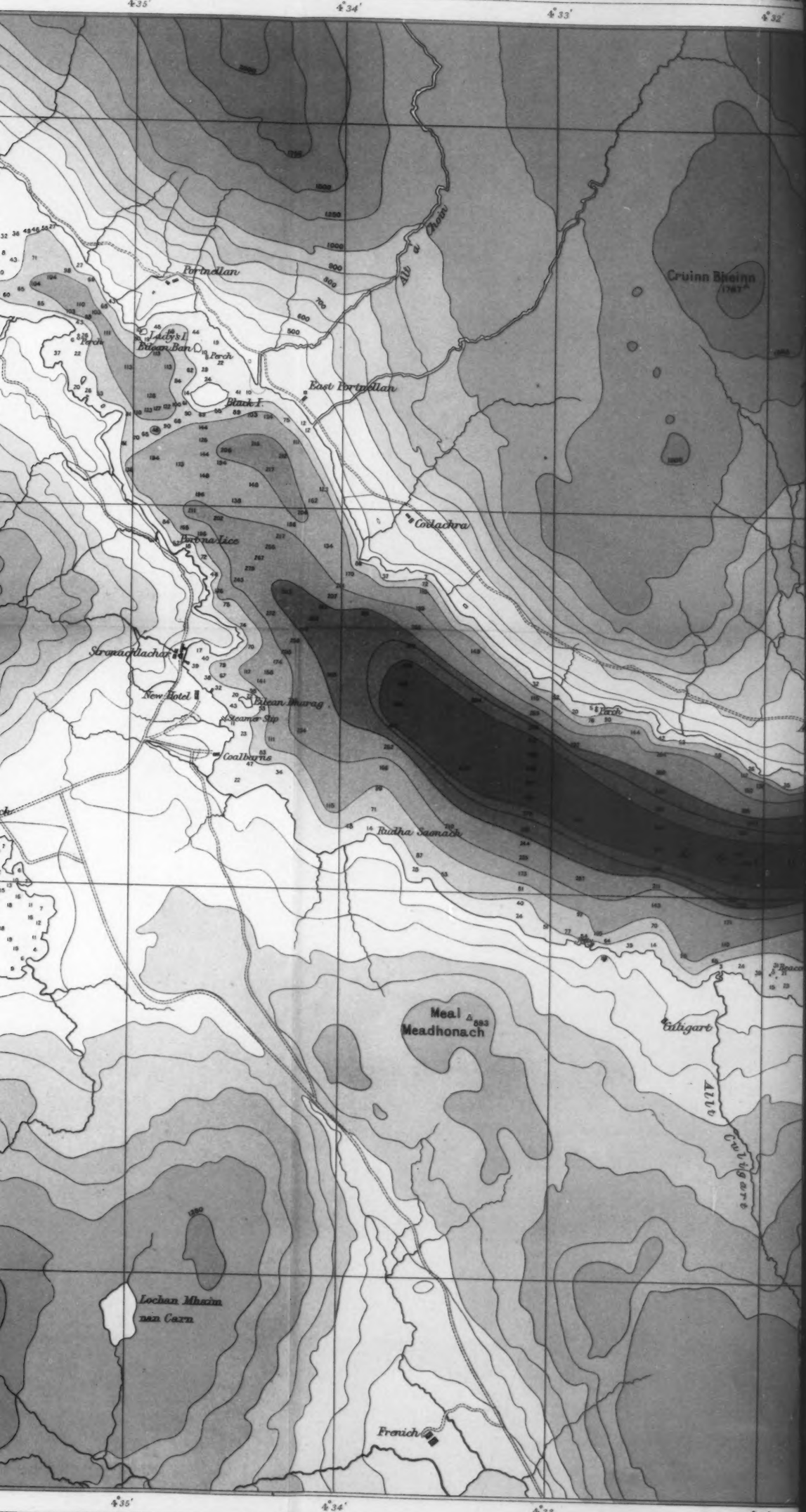
BY SIR JOHN MURRAY, K.C.B., LL.D.



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SURVEY OF THE SCOTTISH LOCHS.

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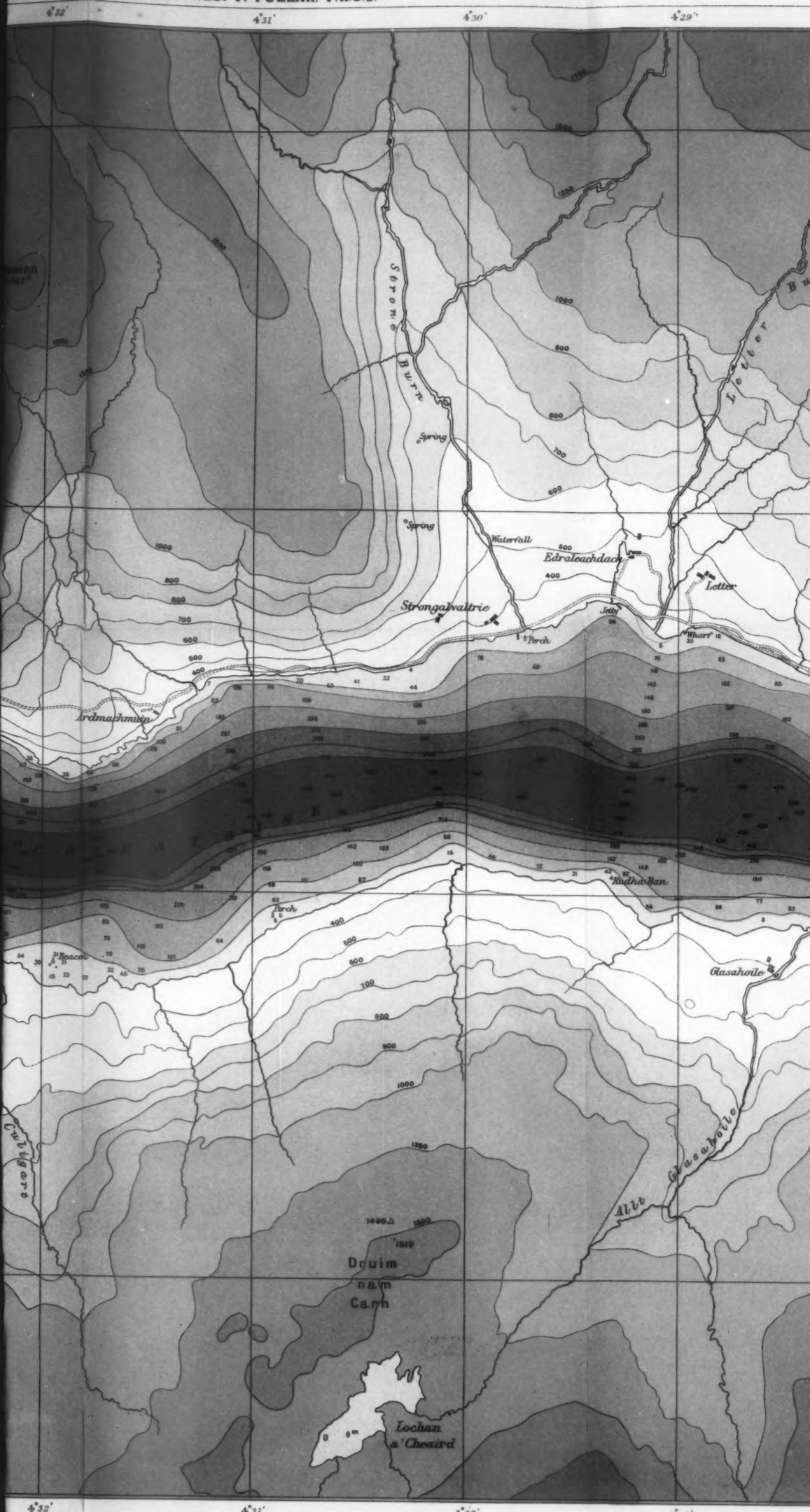
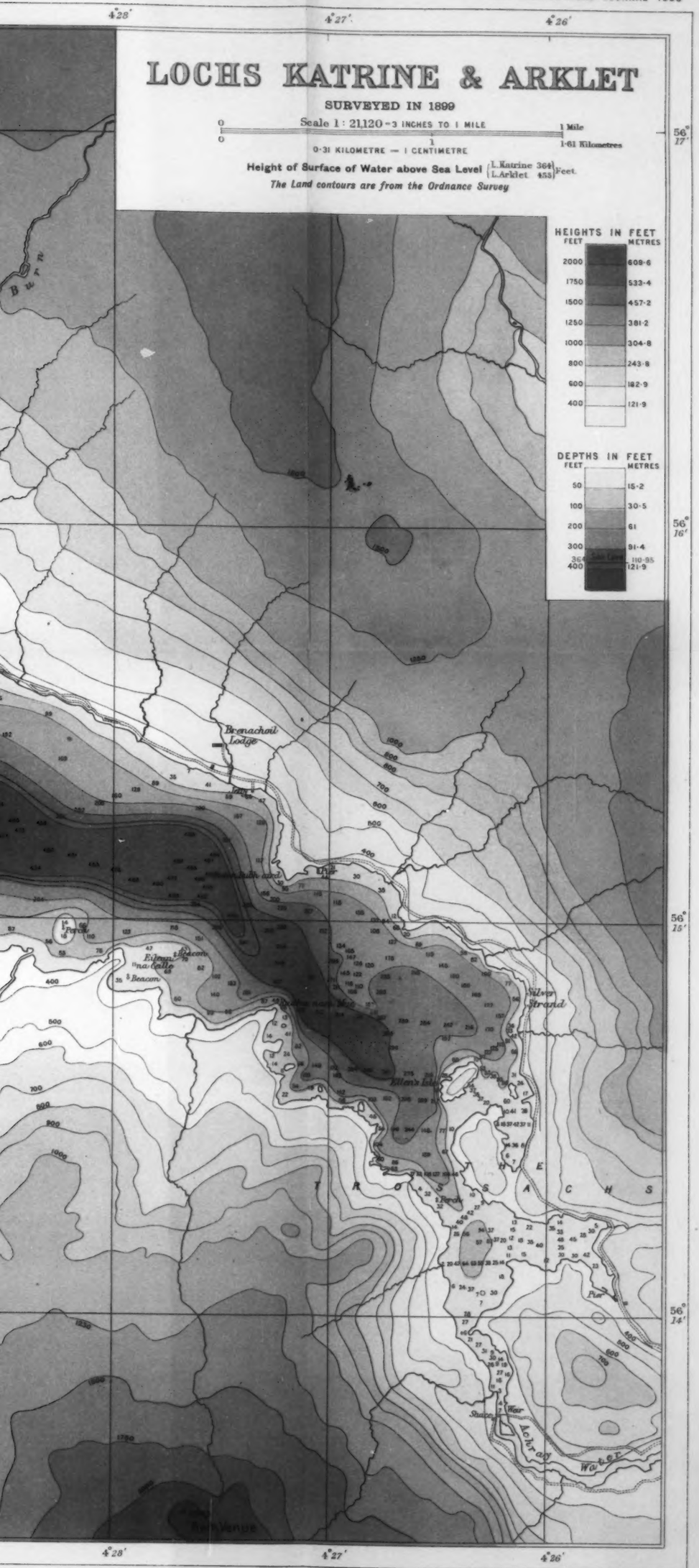
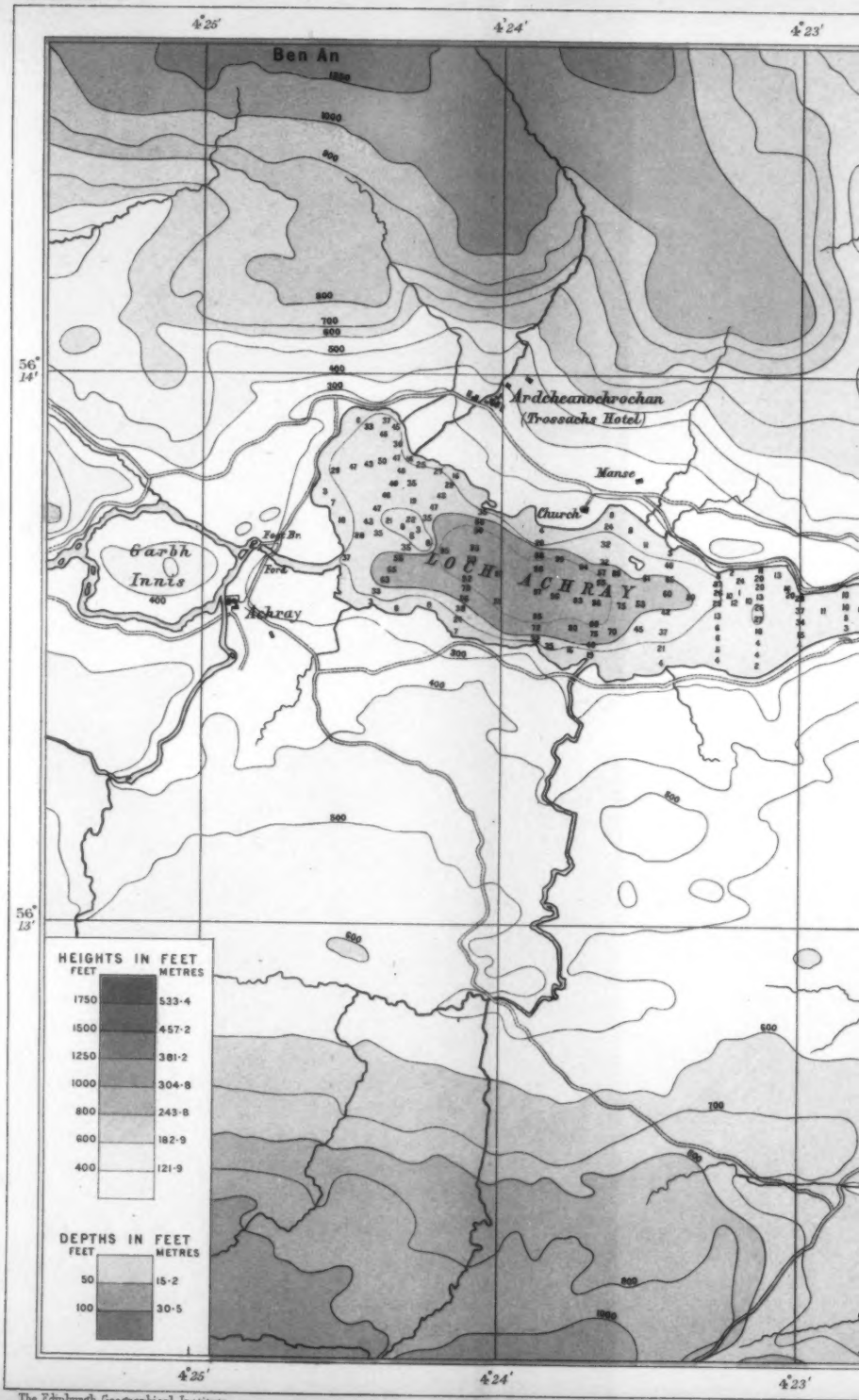


hed by the Royal Geographical Society.



J. G. Bartholomew.

PLATE V



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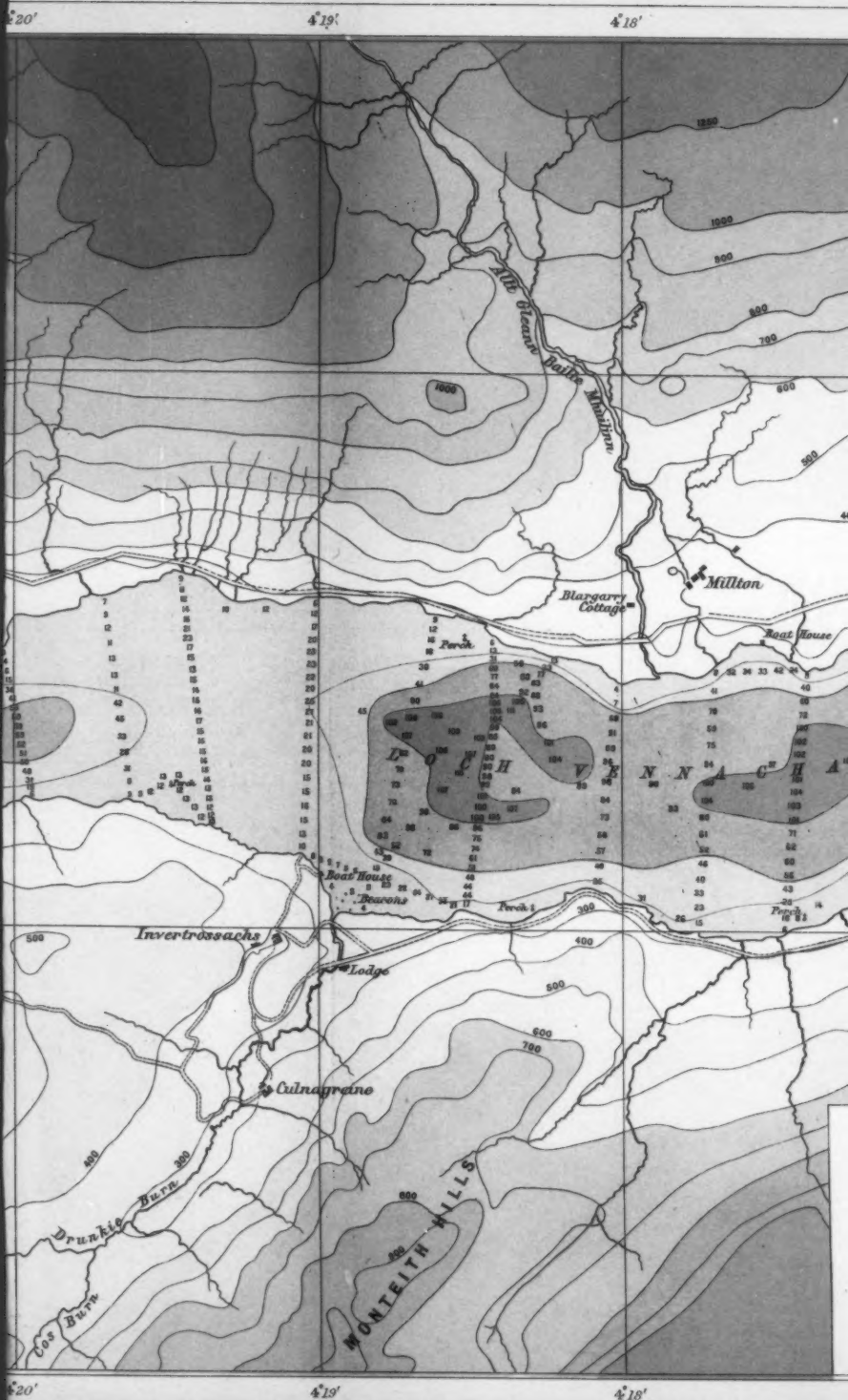
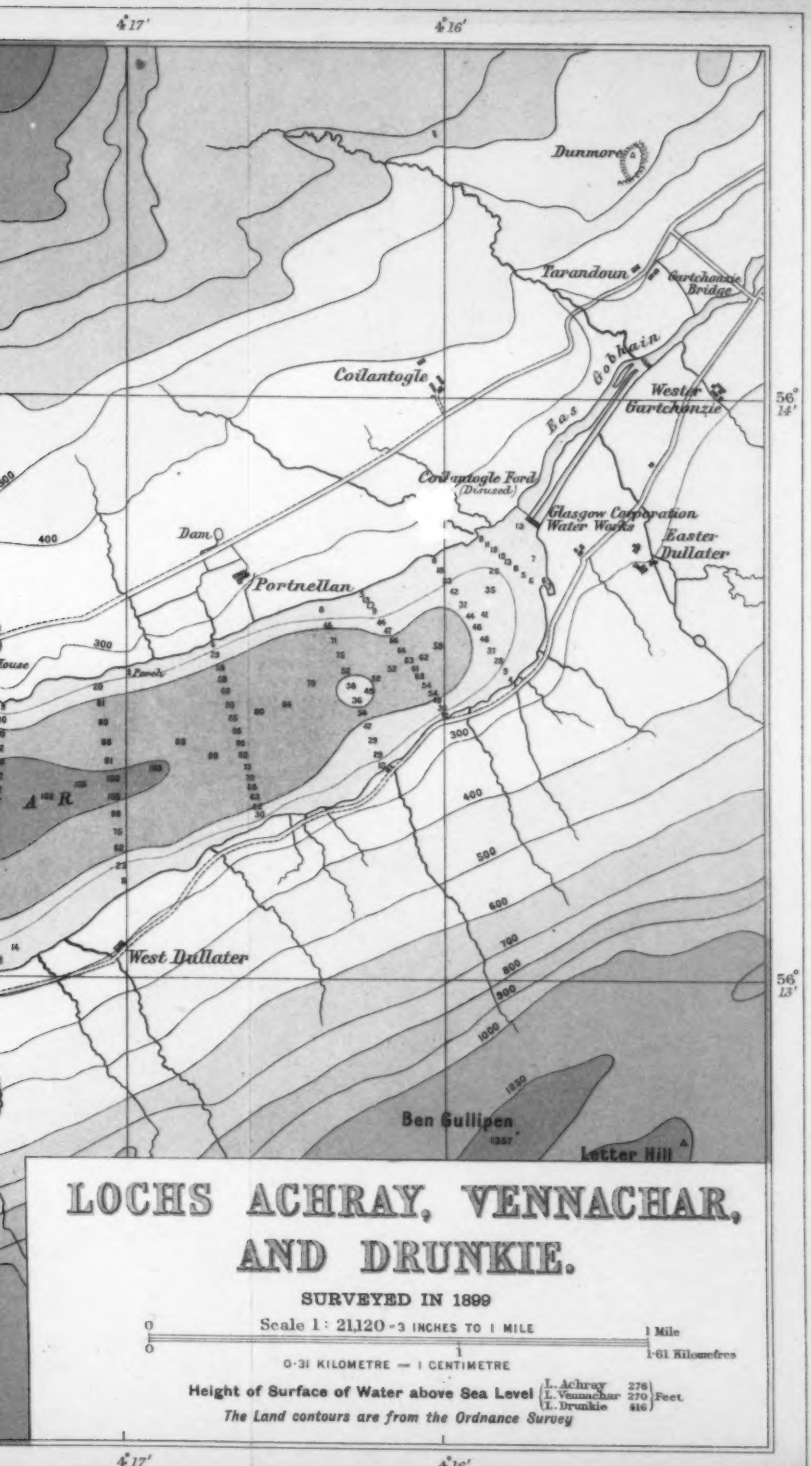
THE SCOTTISH LOCHS.

ND FRED. P. PULLAR. F.R.G.S.





LOCHS ACHRAY, VENNACHAR, AND DRUNKIE.

SURVEYED IN 1899

Scale 1 : 21,120 = 3 INCHES TO 1 MILE

0 — 1 Mile

0 — 1 — 1·61 Kilometres

0·31 KILOMETRE — 1 CENTIMETRE

Height of Surface of Water above Sea Level

L. Achray	278	Feet.
L. Vennachar	270	
L. Drunkie	416	

The Land contours are from the Ordnance Survey

J. G. Bartholomew.

BATHYMETRICA

PLATE VI

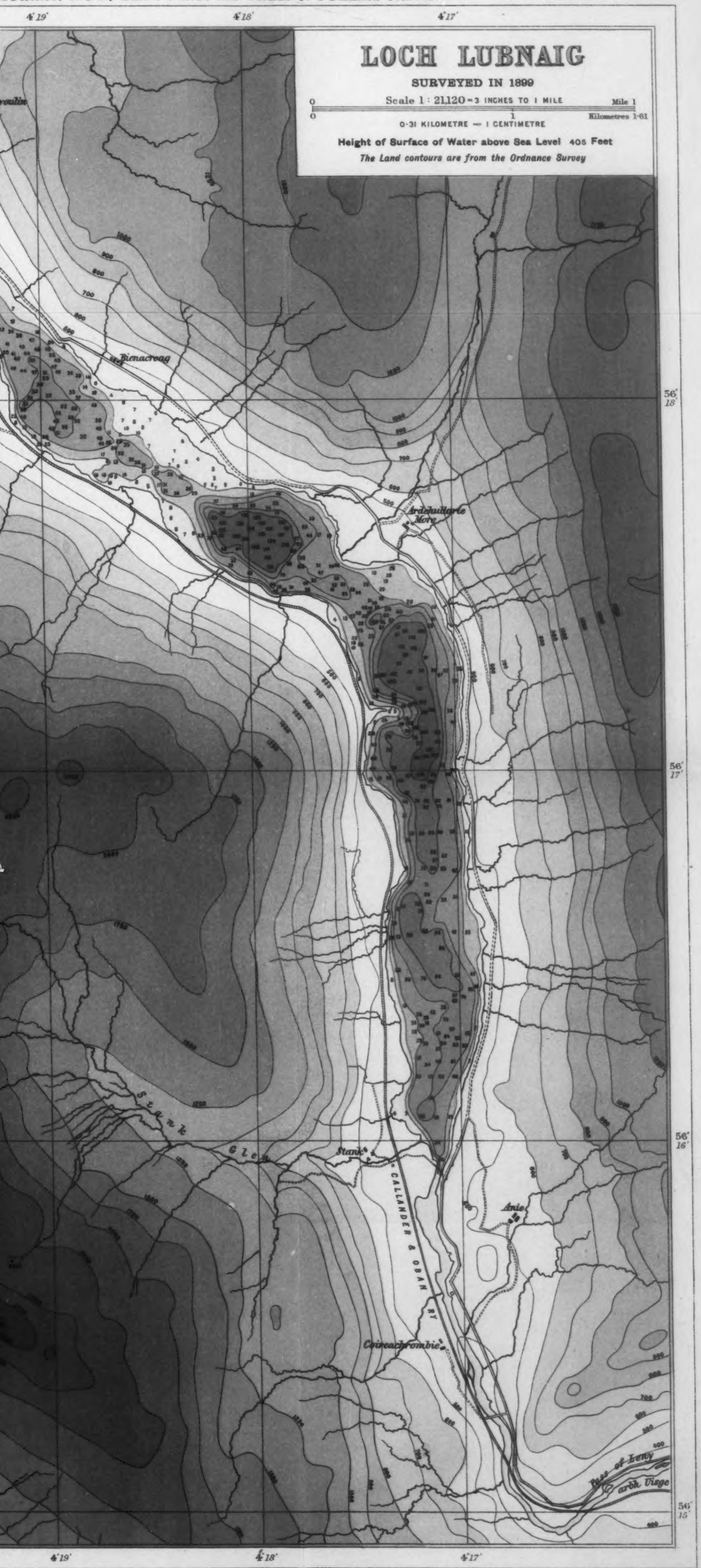
By Sir JOHN MU

The Edinburgh Geographical Institute

...CAL SURVEY OF THE SCOTTISH LOCHS.

...MURRAY, K.C.B., LL.D., F.R.S., AND FRED. P. PULLAR, F.R.G.S.

THE GEOGRAPHICAL JOURNAL



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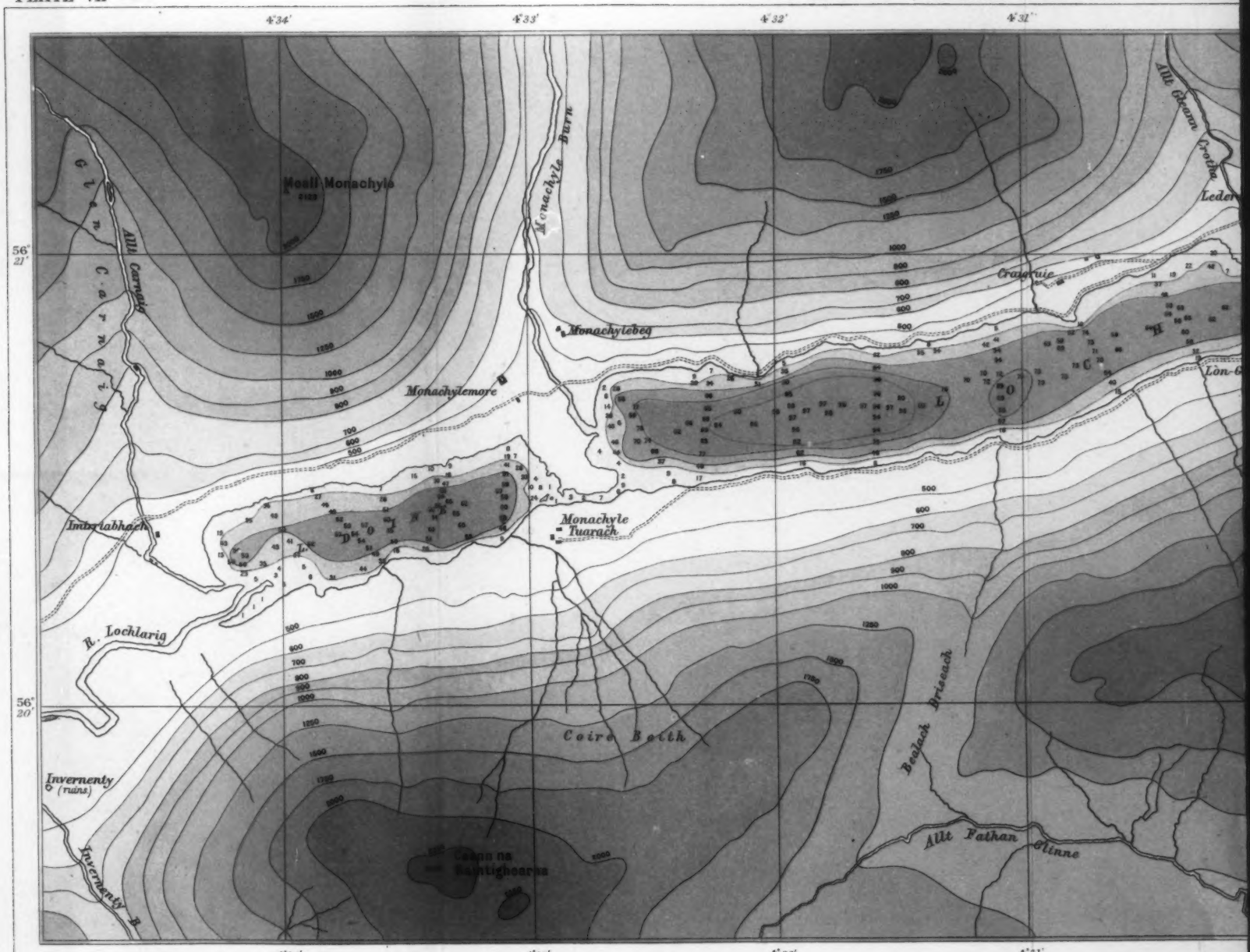
BATHYMETRICAL SURVEY OF TH

BY SIR JOHN MURRAY, K.C.B., LL.D., F.R.S., AND

PLATE VII



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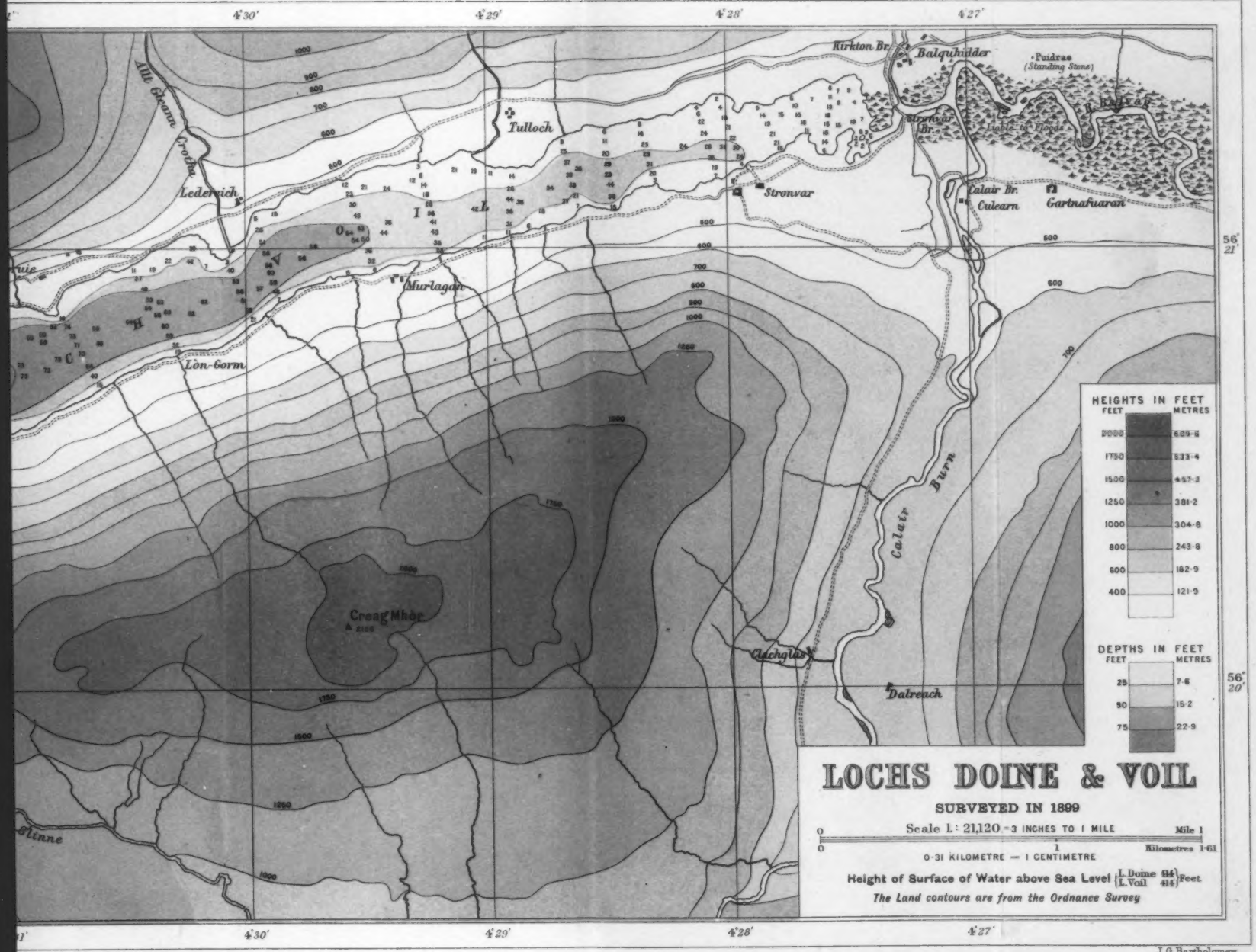
URVEY OF THE SCOTTISH LOCHS.

K.C.B., LL.D., F.R.S., AND FRED. P. PULLAR, F.R.G.S.



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